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JOHN DALTON, LL.D., F.R.S., &c.

IS it possible for the present generation to realize the old landmarks of science, and to recognise and honour the simplicity of past times? It is; most decidedly, it is. That story never can become vapid. A nation that honours its forefathers can afford to recall the rough-hewn ways by which its present exists, and upon which it is founded; because the foundation was sound. The edifice has not been erected upon the sand; it was built upon a rock, and the storm and whirl of modern machinery, and the race and rage of competition, and the disproportionate relation of cost and effect, which prevail in our time, can never, with all their beatings, dissolve the structure. Gideon Mantell and his *confrères*, hiring a loft in Lewes for a shilling a week, and conversing under the glare of a rushlight, were happy and wise. For them no carpeted floor or mirror had a charm, and the rudeness of the winter had no effect. They knew not what was in them, nor sought to know what would come out of them. They obeyed one particular law of human-kind in exercising and making practical the faculties with which they were endowed; and whether pleasure or plunder offered temptation, both had cause to know that no charm of theirs would divert them from obedience to the divinely-human instinct of their lives.

Such was John Dalton. In looking over the list of subscribers to his 4*s*. book of Meteorological Observations and Essays, published in 1793, we see how humble was the enterprise. There were only 107. How many publishers now-a-day could accept such a list: how many printers? But there was that dear William Allen, whose form can never be effaced while the memory of the writer "holds its seat," and the ever-recurring names of Gurney, Barclay, Birkbeck, Hodgson, Hutton, Priestly, Wright, and Strickland, all of quiet habit and generous being,—persons that followed the light that was in them, and loved to communicate their gifts, whether of money, patronage, or kindness, to those of like spirit wherever they might be found.

The Society of Friends is entitled to the honour of creating all the energetic and fruitful popular education we possess. The Nonconformists have claimed it often; but in truth they were only the hewers of wood and the drawers of water in that great development. The "light that was in them" led the Quakers to the kind, cheap, and useful. They practised the intelligence in their works. Their simplicity of habit and their purity of mind made them the exemplars and the communicators of a power that electrified the Nonconforming and Unitarian elements of English life into something like a consciousness of public obligation; and enforced the birth of the British and Foreign School and the Society for the Diffusion of Useful Knowledge.

Dalton belongs to the Quakers. Their habits, society, and intellectual characteristics are reproduced in his life. At a village, Eaglesfield, Cumberland, wherein was the first meeting-house of that Society, he was born. The old meeting-house has become a school-house, as have many others elsewhere, and the long grass grows over the tombs of the early Friends. His father, a woollen weaver, did not reside in the house belonging to his workshop, but dwelt in a cot of two rooms at that time. He was a very poor man who could only weave common country goods, and his earnings were augmented by his wife selling simple stationery; but he taught his children mathematics in the practical forms of mensuration and navigation. When his brother died without an heir he had possession of the estate, and gave up weaving. The change of circumstances enabled Joseph Dalton to send

John to the Friends' School, where he remained until twelve years of age, and then began to teach at the Meeting House during the winter months—the time for study and for learning—while in the summer he took his turn on the farm of his father. For the most part his pupils were older than himself, and the contests to maintain order often required the arbitrament of physical force, which Dalton's authority could either accept or give an equivalent by locking up the refractory, who then broke his windows. These occupations improved his physical and mental powers. Study and exercise took their alternations in a course that made him a very healthy man for many years. The further advantage he gained—as we have seen in the lives of others—was, that while the farm labour found provision for his bodily wants, his mental acquisitions were free from the burden of pecuniary care, and rendered him independent in mind and among his scholars.

But, as it has been in many a young life similarly placed, it must not be forgotten that at ten years of age he had the notice and assistance of a gentleman, Mr. Robinson, of the neighbourhood. How many gratefully remember such assistance in those old days when schools were scarce and inefficient! It was by such aid his mathematics grew. A companion shared his lot, of the name of Balderstone, and he bet Dalton sixpence on a geometrical proposition. Mr. Robinson ordered that the bet should be changed, and that the loser should find the winner in a winter's candles. Dalton won and the conditions followed. He had previously laid down the difference between sixty square yards and sixty yards square in a dispute among the farm folk, and his repute grew. It was a life of keenness and diligence, but of innate humility. The language he used did not verge from the provincialisms of Cumberland, and his reading then or afterwards was comparatively slight. His force lay in the power of mental concentration, and as his earliest educational acquirements had to do with space and number he applied all his power of thinking to those objects and their correlation.

The school at Eaglefield engaged him for nearly three years, when he left to assist his cousin Bewley in a school at Kendal, at which place his elder brother had previously been engaged. Here he remained twelve years, during which period his mind took its precise and definite direction. His duties made it necessary to learn somewhat of Latin and Greek, and his mental habit enabled him to retain every word he chose to fix upon his memory; the advantage he obtained lay however in the increase of breadth and the growth of power, and not in philological attainment. Nevertheless, his prospectus, 1785, states, "where youth of both sexes will be instructed in English, Latin, Greek, and French; also writing, arithmetic, merchant's accounts, and the mathematics at 10*s.* 6*d.* per quarter," which terms were raised some twenty-five years after by his brother to 15*s.* per quarter, with an apology about the dearness of provisions. In a postscript was added the observation that youth are boarded in the master's house, &c.; and to do this Mary, the sister, came, and the old people, now alone, would come now and then to see them, and to do so would walk over forty miles across the country. Bewley had left the school and lent them capital and furniture, and their father also helped. The debts were cleared in a year, and this by dint of exceedingly strict economy. They realized £70 a year, and added to the fund by sundry semi-legal matters for neighbours. In the second year their circulars had more than twenty items, with an intimation to the public that they could teach more pupils. John about this time made the acquaintance of a blind devotee of science, John Gough, the son of a Kendal trader, of whom he wrote in 1834, after that gentleman's decease, 'Mr. Gough might justly be deemed a prodigy in scientific attainments considering his disadvantages. He lost his sight by small-pox in infancy, but lived a happy and useful life to a good old age. His education qualified him to employ his great powers in the study of the physical and mechanical sciences. He acquired an excellent or a competent knowledge in the several branches of astronomy, optics, pneumatics, chemistry, general and natural history, and botany. For eight years we were intimately acquainted, and he was as much gratified in imparting his stores of science as I in receiving them. My use to him was chiefly in reading, writing, and making calculations and diagrams, and participating in the results of successful investigations. He would receive no recompense, and therefore the balance was in my favour. I am glad to acknowledge it. He it was who first set the example of keeping a Meteorological Journal at Kendal." This journal, kept by Dalton, extended over forty years, and was of immense importance in those early days of meteorology. The example was followed all over the country, and we remember in 1832 seeing one in Sussex which began in 1826, and continued some thirty years after that, and may do so now.

In 1787, John Dalton commenced lecturing on Natural Philosophy, at his school, for half-a-guinea the series, or a shilling each. They run over the old topics—mechanics, optics, pneumatics, astronomy, use of the globes, and a good outline it was. It is not known whether the condition of the announcement—provided a "sufficient number of subscribers was procured"—was conformed to, but John Dalton then began lecturing. The brothers were rough Cumberland men. Our John enjoyed the greater favour, being of milder habit, and also in that his custom of making mathematical calculations on scraps enabled him to enjoy a little laxity that might not have been allowed. He was ever stern and gentle: it could not be otherwise, for he had no companions, and his life was studious and abstract. He had his games, but they were all recorded. Even when as youths they took to rhyme-making, village fashion, the result is noted and the winner too.

It was about this time he set up the making of his own barometers and thermometers, making experiments on hygrometers of whip-cord—collecting butterflies, and making up arboretums. His *Hortus Siccus*, collection of dried plants in books, exended to twelve volumes, and was, like many others that we have seen, especially among the Society of Friends, not so particularly exact, but exhibiting wide knowledge and incessant industry. His scientific instruments he made at first by imitation, and afterwards improved them by observation. All these circumstances enlarged his acquaintance as well as increased his powers, and he began to fret under the restraint of school-keeping, and to thirst for a larger variety in life. At first the bar and the hospital were suggested, but the prudence of the Friends preferred the functions of attorney or apothecary. To test his capacities he began to make medical experiments, with a view of ascertaining the loss of the human body from insensible perspiration. It was evident he would never do for a surgeon or apothecary if he intended to commence by studying what might be without making use of what was existing; and abandoning all further desire of change, he remained at Kendal until 1793, when his friend Gough received an application from Dr. Barnes for a proper teacher of mathematics in Manchester New College. Dalton had the offer, which he accepted, and for six years he held the post of tutor in mathematics and natural philosophy; for which honour he was indebted, not only to the introduction of his friend Gough, but to the fame which his volume of Microscopical and Philosophical Essays had brought him. This book he reprinted intact forty-one years after, and to show the pains he had taken, and the qualification he possessed in his young days, he says, in his 1834 edition :—"Forty-one years have nearly elapsed since these Observations and Essays were published. They have long been out of print . . . It may be expected that such a lengthened series of observations as I have made since must have afforded abundance of important matter to be added. I have not found this to be the case. This edition is *verbatim* from the first in texts and notes, only adding a few notes as a second appendix, and some observations on clouds, thunder, meteors, aurora borealis—the result of my forty years' notes of the phenomena. I have been the more anxious to preserve the first edition unchanged, as I apprehend it contains the germs of most of the ideas which I have since expanded more at large in different essays, and which have been considered as discoveries of some importance; for instance, the idea that steam or vapour is an independent elastic fluid, so largely insisted upon in the sixth essay, and hence that all elastic fluids, whether alone or mixed, exist independently. The great principles of motion in the atmosphere, the theory of winds, their effects on the barometer, and their influence in the production and regulation of temperature and of rain, are of primary consideration in every department of meteorology. These were pretty fully developed in the second and succeeding essays."

Before passing on, we make an extract from one of these appendix notes, which exhibits the daring of his genius as much as his scientific acquirements :—"I consider it almost beyond doubt that the *light* of the *aurora borealis*, as well as that of falling stars and the larger meteors, is electric light solely, and that there is nothing of combustion in any of these phenomena. Air, and all elastic fluids, are reckoned amongst the non-conductors of electricity. There seems, however, a difference in this respect: dry is known to conduct worse than moist air, or air saturated with vapour. Thunder usually takes place in summer, and at such times the air is highly charged with vapour; when it happens in winter, the barometer is low, and, consequently, according to our theory of the variation of the barometer, there is then much evaporized air; from all which it seems probable that air highly vaporized becomes an imperfect conductor, and, of course, a discharge made along a stratum of it will exhibit light, which I suppose to be the general cause of thunder and lightning.

"Now, from these conclusions we are under the necessity of considering the *beams* of the *aurora borealis* of a *ferruginous*

nature, because nothing else is known to be magnetic, and, consequently, that there exists in the higher regions of the atmosphere an elastic fluid partaking of the properties of *iron*, or rather of *magnetic steel*, and that this fluid, doubtless from its magnetic property, assumes the form of cylindric beams. It should seem, too, that the rainbow-like arches are a sort of rings of the same fluid which encompass the earth's northern magnetic pole, . . . and that the beams are arranged in equidistant rows round the same pole. . . . This elastic fluid of magnetic matter is an imperfect conductor of electricity; and when the equilibrium of electricity in the higher regions is disturbed it takes these beams and rings as conductors, and runs along from one quarter of the heavens to the other, exhibiting all the phenomena of the *aurora borealis*."

Dalton's views did not find the acceptance they deserved from the men of science. He devised new terms, and that gave offence; and the dilettanti authorities complained about his abrupt, and, as they chose to call it, ineffective manner of elucidation. He rejected in the most imperious manner the logical faculty, and preferred the interpretation drawn from the senses. He would see. He would have his conclusions tested by observation. He had seen, and in his rough way he would at least attempt to make others see, and the result has been that no one can shake the propositions he enunciated. The grandeur of his life is herein manifested and exemplified. The best sanction to the justice of his views is the entire adoption of his manner of illustration by one of the most eminent chemists of his day, Dr. Hoffman, who lectured at the Royal Institution some years after Dalton propounded his theories.

It may be that in the higher acceptation of the term Dalton may not be recognized as a man of genius. He may not have had the power of surveying the vast region of undiscovered truth, but he had the sagacity and daring of an independent thinker, who, rejecting all accepted theories, based his convictions and elucidations upon discovered facts, and these he brought out from personal observation, according to his especial way, by dint of labour carried through in an orderly and exact manner. Herein lies his claim to be ranked and regarded and admired as one of the keenest philosophers which our country has yet produced.

He did not die unhonoured. When Sir Humphry Davy died the French Academy elected Dalton one of its eight Foreign Associates, and that is one of the highest honours science can command in France, and although remarkable for his abstinence in the matter of distinction, it was not long before the Royal Academy added to his fame the award of the first of the royal prizes given after its institution. And when the British Association was instituted Dalton was among the first in labour and in honour. He had lived a life of seclusion, and few knew him beyond the inner circle of science, and when the Quaker philosopher stood up in that assembly there was a presence at once interesting and deserving of regard. His simple manner, no longer angular or uncouth, touched the hearts of all and won for him an affectionate veneration which never was disturbed.

At the risk of repetition his fame must be recorded. Oxford conferred the D.C.L., and so did Edinburgh. The Civil List bore his name for £150 a year, under the enlightened government of Lord Grey. Manchester subscribed £2,000 for his statue, which was executed by Chantrey. When Dalton came to London to sit to the famous sculptor for this statue, he was called upon to go to Court with his friend and introducer Mr. Babbage, of Dorset Street, Marylebone, the famous calculator. He had some hesitation as to accepting such an honour, and the question of Court-dress interfered; but the habiliments of the Oxford D.C.L. arrived, and in a private room William the Fourth received the man he had known well enough to respect, and in the kind and homely fashion well recognized by those who, like ourselves, remember the Sailor King, entered into a long conversation—so long that Babbage said he heard a Court officer remark to his mate, "Who the d—l is that fellow whom the king keeps talking to so long?" There was the Quaker, clothed in his ecclesiastical Quaker costume, adorned with the scarlet robe of Oxford.

Ten years more of honour and peace remained to him at the disposal of the Father of all, and they were years of gradual decay in bodily and mental power. Paralysis followed upon paralysis until he passed away. When he died Manchester conferred upon him all the honours she could command. The town went into mourning; his body was laid in state, and as long as Owen's College remains his name will be cherished.

W. S. C.

STREET AND TRAM LOCOMOTIVES.

IN our number for June (page 176 of the present volume) we inserted, from the "Journal of the Franklin Institute," a few paragraphs concerning the use of steam carriages on street railways and common roads. At page 188 we gave a description and engraving of Messrs. Merryweather's steam tram-carriage, lately commenced working on the Paris tramways. It occurs to us that it may be useful to present here a few connecting links of history, so as to prepare the general reader for a due comprehension of other novelties which are likely to make their appearance ere long. Railways, as we all know, have solved the problem of steam-power *v.* horse-power, so far as regards the traction of heavy loads at high speed. It remains still to be ascertained whether this substitution ever can or will be so complete in regard to what may be called "omnibus traffic," distinguished by lighter loads, lower speed, and more frequent stoppages. It becomes, on this account, interesting to glance at the inventions which, from time to time, have been brought forward, partly for steam-traction on tramways, but more generally for use on common roads.

If we mention Sir Isaac Newton's name in connection with this subject, it is only in relation to a speculation which he made no attempt to put to a practical test. He suggested a globular vessel, placed on four small wheels, with a jet-pipe on one side and a driver's seat on the other. Steam, generated in the globe by a suitable fire, would issue from the tube and drive the little four-wheeler onward by reaction, on the principle of the rocket. Dr. Robinson, nearly a century later, communicated to James Watt an idea for the propulsion of a carriage along common roads by steam. A cask of iron-bound staves for a boiler; an iron furnace or fire-box, fed from above, immersed in the water in the cask; steam from the heated water moving a piston in a cylinder, and the piston moving a small wheel-carriage on which the cask, &c., were placed,—such was the idea; but Watt carried it no further than the sketching of a few drawings.

Of those who really advanced to the stage of an actual carriage, or at least a working model, one of the first was Cugnot, who made a rude model, still preserved in one of the public museums of Paris, and then a carriage, which proved to be too energetic at its work, for it dashed through a brick wall and brought disfavour to its inventor. William Murdoch, about 1790, ran a steam carriage on the highway near Redruth, but the chief fact now known concerning it is, that the Cornish miners rushed away in affright from "the fiery little monster running along the road without horses." William Symington, whose name is as favourably associated with the history of steam navigation as Murdoch's with that of gas-lighting, exhibited at Edinburgh a model of a steam carriage, the merits of which he was unable to test by reason of the wretched state of the roads. Oliver Evans, of Pennsylvania, proposed to the legislature of that state a scheme for steam traction on common roads; his plan met with no response. He was greatly laughed at for prophesying that the day would come when such carriages would attain a speed of fifteen miles an hour. Who was nearer the truth, the derider or the derided?

Early in the present century we find Trevithick and Vivian completing and running their steam carriage on the very spot where the Euston station now stands—not a bad association of ideas, it will be admitted. From the description published, it seems to have been a tolerably light and compact piece of mechanism. A carriage rested on four wheels, of which the front pair guided or steered, while the hinder pair supported the greater part of the weight; a boiler and a horizontal cylinder were placed at the back of the hind axle, while rods, toothwheels, cranks, &c., connected the piston of the cylinder with the wheels of the carriage.

Nobody took up these schemes in earnest—war and political troubles occupied men's thoughts in other than peaceful pursuits. But a new spurt took place just about half a century ago. Mr. Griffiths employed Bramah to work out an idea of his, and to make improvements in practical details. Little is now known of the steam carriage which resulted from this partnership in ingenuity, except that there were two cylinders with pistons, a tubular boiler, and vertical springs to deaden the concussion. Another inventor, David Gordon, had firmly persuaded himself that no locomotive carriage, or steam engine on wheels, can travel up an incline. He therefore devised a strange monster, with six jointed levers to act like six legs, with bending movements to imitate those of knees and insteps, the legs alternately stepping and dangling! Another mode of overcoming the supposed difficulty was by putting a steam engine inside a large iron drum, making the engine roll the drum as a squirrel rolls his cage, and a carriage to roll on after the drum.

When it was proved that a locomotive *can* travel up hill, if not steep, inventors took courage, and novelties appeared in rapid succession. Goldsworthy Gurney built a steam carriage which Sir Charles Dance "tooled" (as coaching men would call it) between Gloucester and Cheltenham. It ran to and fro four times a day, doing the distance of nine miles in about an hour. All kinds of obstacles were thrown in his way. Innkeepers, hostlers, horse-dealers, coach-makers, road trustees, interposed impediments wherever possible. Gurney and Dance were beaten; but nevertheless they obtained a favourable report from a committee of the House of Commons. The committee, fairly judging the evidence brought before them, reported that the steam carriage could maintain an average speed of ten miles an hour; that it would carry twelve or fourteen passengers; that the total weight of carriage, machinery, fuel, water, passengers, driver, and attendant, might be under three tons; that the carriage, with such a load, would ascend and descend ordinary roads with facility; and that the broad wheels were less likely to cut up the roads than the narrow wheels and horses' feet of ordinary road vehicles. Whether the system would eventually be cheaper than horse-traction could not be determined on so short an experience.

Captain Ogle was another experimenter in the same line. He made a great sensation by running a new steam carriage from Oxford to Birmingham, ten miles an hour in the towns and twelve miles in the more open country. His contrivance was a kind of mail coach for six inside passengers and eight outside, the motive power being placed in the rear of the passenger compartment. Rivals appeared in this district and in that, but all went into oblivion after a brief period of excitement. Mr. Hancock's "Infant" steam coach plied for a time to and fro between London and Stratford. A steam coach, under the command of Colonel Macerone, in like manner had its little day. Mr. Scott Russell (perhaps the only distinguished living representative of that group of inventors) constructed a steam carriage which plied for a time between Glasgow and Paisley. Burstall (a name that might be regarded as rather ominous in connection with such subjects), with his partner Hill, Summers and Ogle, Dance and Field, James, Heaton, Church, Squire, Hills, Sir James Anderson—all are to be included among the inventors who turned their attention to these matters at various periods from half a century to a quarter of a century ago. Why they all failed we need not wait to say. Some of the engines were too heavy; some had difficulty in maintaining their water-feed; some did not steer readily nor stop with sufficient promptness; some frightened the horses with their noise; while others were placed beyond the reach of profit by inordinate tolls imposed by turnpike trusts.

There is still no paucity of invention of steam coaches, if the smallest encouragement be offered to them. The Earl of Caithness created quite a lively sensation in Scotland a few years ago, by performing a journey which certainly was unequalled of its kind. A very ingenious steam carriage was invented by Mr. Rickett. It was a kind of hooded chaise, with a small steam engine behind it, occupying about as much space altogether as a horse and chaise; the chaise had a seat for three persons, while the engine was attended to by a fourth person, stationed in the rear. A supply of coal for fifty miles and of water for fifteen could be carried; when thus supplied, the whole affair, with four persons, weighed about a ton and a half. On a given day the Earl started off, occupying the position of driver, with the Countess of Caithness by his side, a clergyman at the other end of the same seat, and Mr. Rickett acting as stoker. On they went, starting from Inverness, and taking the mail coach road through Beauly to Dingwall, Golspie, Durabin, Helmsdale, the Ord of Caithness, Berriedale, Wick, to Barrogell Castle—a ride of 150 miles. The ascent and descent of the Ord of Caithness, one of the stiffest bits in Britain, showed that the wheels of the little vehicle took a good hold of the road.

Without touching further on these steam coaches, we may say a few words concerning the use of traction engines for dragging heavy weights over bad roads, or rough ground without any road at all. The success of these is beyond all question. One of the first was Taylor's "Steam Elephant," employed at Messrs. Laird's to drag marine boilers and other heavy masses of iron from the works to the harbour at Birkenhead. It was afterwards used in other places, usually to support a powerful crane, which lifted up heavy weights, wheeled them along, and deposited them at another spot. The "Steam Bull" was a rival to the "Steam Elephant," and used in a similar way. Bray's traction engine, at one of its early trials, carried or drew a boiler of 30 tons, an armour-plate of 17 tons, and two other plates, all at once. One of these engines, sent out to the South American mines, rendered great service at a spot where there were literally no roads, lowering ore down from the mine to the harbour, and dragging up stores. Avelong and Porter's traction engine is another of these excellent contrivances, adapted for various kinds of farm and quarry work, and as a feeder to railways along roads where the traffic would be too small to pay for a rail. Thomson's engine is also remarkable, noticeable for the thick bands of india-rubber which form the tires of the wheels, and enable them to get over rough ground without much jolting.

As to steam vehicles on the common roadways of streets in our busy towns, we are almost as much without them now as ever. The chief exception is the road-roller, used for crushing and smoothing the surface of newly macadamized carriage-ways. The legislature has hitherto discouraged rather than encouraged the appearance of "Puffing Billy" in our streets. In 1862 an Act was passed to regulate the employment of locomotives in the streets, under the belief that they were at that time coming into use. The weight and the gauge were to be limited; they were to consume their own smoke; they were to carry lights at night; they were to carry a guard as well as a driver and a stoker; and they were not to exceed a speed of five miles an hour in towns. Another statute, in 1866, made matters still more stringent, by enacting that the speed should be lessened to two miles an hour in town streets, with a man running on ahead on foot, waving a red flag, to warn persons to keep out of the way; and noisy steam whistles were interdicted. Whether commercial traffic could live under such iron rules, the future may perhaps show; steam omnibuses for passengers would obviously find no trade at two to four miles an hour.

Tramways, as we all know, had a precarious infancy in this country, but they have surmounted their preliminary troubles, and have become fairly remunerative undertakings. The high price of hay and oats gradually led the companies to inquire whether the tram cars could be safely and profitably drawn by steam-power. Foreign countries have preceded us in this application. Kohl's steam cars (an illustrated description of which appears in our last number) have, for some time, been working successfully in the streets of Copenhagen; Harding's in Paris, and others elsewhere. An arrangement by Messrs. Merryweather was tried for some time in Westminster, but circumstances were unfavourable to its success. A greatly improved construction by the same makers is described on page 188, illustrated by an engraving; this has been brought into use on some of the Paris tramways. Mr. Grantham invented a steam car, which was tried experimentally at West Brompton, and is now, we believe, working on a short bit of country road; he planned many improvements in it, but did not live to finish them. Mr. Hughes, of Loughborough, who has built many small locomotives for use on mineral railways, has recently adapted them for a tramway at Leicester. His tram locomotive has a pair of 6-inch cylinders, 12-inch stroke; as it is fed only at the beginning of each journey, there is no need for a fuel-box. Coke is used to prevent smoke; the chimney does not protrude above the roof, and the working mechanism is boxed off to avoid frightening horses. The weight of engine and car, with coke and water for six miles, is about five tons.

Within the last few weeks a trial has taken place on the Hoylake and Birkenhead Tramway of a tram locomotive by Woods, intended for Vienna. The engine and car form parts of the same structure. Shand and Mason's patent inclined water-tube boilers are employed. The cylinders, 6-inch diameter and 9-inch stroke, are placed under the platform, and are coupled direct to a pair of steel driving wheels, 2 feet diameter. Each end of the car has its own break, steering gear, and passenger entrance. The boiler is at one end, while the other end is supported on a bogie-truck. One man can manage the driving, stopping, stoking, &c. The car will carry twenty passengers. The water tanks are placed under the passengers' seats, and the boiler can be supplied either by an injector or by a donkey engine.

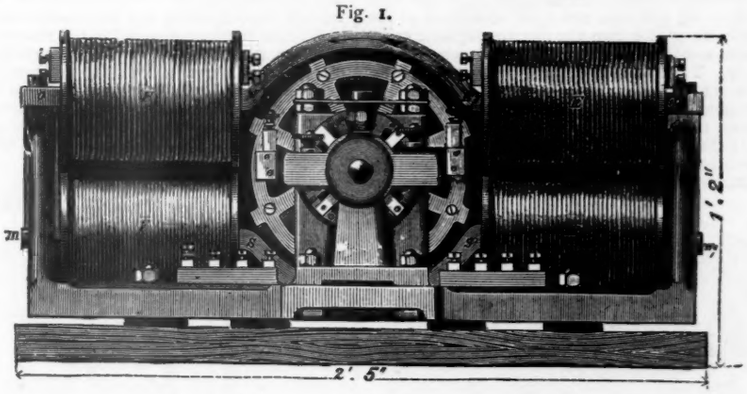
Enough; the future must show whether steam or horse-power is to rule the great systems of tramways. Hitherto, those tram locomotives which have failed have done so because the smoke and heat have annoyed the passengers, or because the noise has frightened the horses of passing vehicles, or because the sunk capital, wear and tear, and working expenses have exceeded the total outlay entailed by horse traction. This last, we suspect, will be the *experimentum crucis*, the real test that will settle the whole question. Say that a large car, carrying forty passengers inside and out, can be drawn along at a fair speed by two horses—what will be the cost of these horses, the renewal, the stable and veterinary expenses, the hay and oats? And what the cost of steam engine, repairs, coke, water, &c.? These are sums in arithmetic which no preconceived theory can solve.

In this connection we now learn that a new steam hand car has recently been designed and constructed by Mr. Jay Noble, master mechanic for M. M. Buck and Co., of St. Louis, Mo.,

which is excellently adapted for the use of division superintendents, road masters, and others whose duty requires them to make frequent inspection of railway lines. The machine resembles an ordinary hand car, except that the propelling power is steam and not muscle. The floor is about 10 inches from the ground, and is beneath instead of above the axles. The boiler, which is about 3½ feet in height, with a diameter of 18 inches, is placed in the centre of the car, while the cylinder, which is horizontal, is at the right hand side and near the floor. The cylinder is 3½ by 6 inches, and the boiler is intended to carry a pressure of 140lb. of steam. The body of the vehicle rests on rubber springs, and rides very easily without lateral motion. Seats are arranged in front and rear, of sufficient size to accommodate six persons. The water tank occupies a space under the back seat and holds about a barrel of water, which is sufficient to run the car forty miles. On the left of the boiler the coal pan is arranged in a space about 2 feet wide, and carries all the fuel necessary for a day's run.

On a recent trial trip, the run from St. Louis to Carondelet, a distance of seven miles, was made in fifteen minutes. The inventor states that under ordinary circumstances the cost of fuel will not exceed three shillings per day. The general arrangement is excellent and reflects much credit on the designer.

Fig. 1.



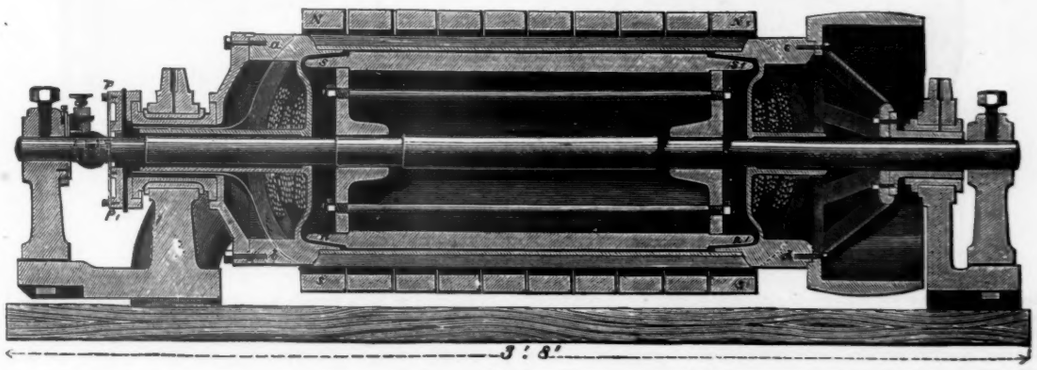


Fig. 2.

ELECTRIC LIGHT.

THE production of light by means of electricity has not been applied in this country to the extent that it apparently might be, and that in time it undoubtedly will be. Its use is being adopted on the Continent in various ways, such as the lighting of railway stations, and the transatlantic steamers running from Havre to New York employ it. There is still much to be done in the perfection of the invention, particularly in the diffusion of the light, which, as at present applied, is directed in a stream from a reflector; but its use in lighting up distant objects makes it invaluable for military and naval objects. Under its cover torpedo operations can be performed in comparative safety to the operators, and recent experiments of the British government, at Stokes Bay and elsewhere, have demonstrated the value of the invention in the illumination of harbours, torpedo experiments, &c. Its value, also, in submarine work, has been demonstrated, and here, where other means of illumination fail for want of the necessary air for consumption, its value is immeasurable.

We purpose, if practicable, to give full descriptions of the several machines that have been invented for the production of artificial light by means of electricity, and we this month present our readers with an illustrated description of Siemens' Dynamo-Electric Machine, which is a *single* apparatus, in which the core of the armature is *fixed*, and the wire-helix alone caused to rotate. By fixation of the armature-core, great inductive power is obtained, and consequently powerful currents. With about 380 revolutions per minute of the wire-helix, and 9-10 horse-power, a light equal to 14,000 candles is obtained. A comparison of the horse-power and number of revolutions required to produce a given number of candle-lights by this machine is instructive:—

Machine of 1·5 h.-p. with 1,100 revolutions gives 1,000 candles.

„	3	„	„	850	„	„	4,000 „
„	6	„	„	480	„	„	12,000 „

When part of a closed electrical circuit is passed between the poles of a stationary magnet, a current is generated in the circuit, the direction of which depends upon the position of the magnetic poles and direction of motion of the conductor.

Upon this principle is based the action of all magneto-electrical machines; but the principle may be subject to modifications having inherent essential differences, as will be seen upon comparison of former machines with that here described.

In this machine (shown in elevation, fig. 1; in section, fig. 2) the conductor, by the motion of which the electrical current is produced, is of insulated copper wire, coiled in several lengths and many convolutions upon a cylinder of thin German silver, in such a manner that each single convolution describes the longitudinal section of the cylinder. The whole surface of the metal cylinder is thus covered with wires, forming also a cylinder closed on all sides (*a*, *b*, *c*, *d*, fig. 2).

This hollow cylinder of wire encloses the stationary core of soft iron (n, s, s^1, n^1, fig. 2). This hollow iron core is made stationary inside the cylinder of wires by means of an iron bar in the direction of its axis, prolonged at both ends through the bearings of the wire cylinder to standards. Surrounding the wire cylinder, for about two-thirds of its surface, are the curved iron bars (N, N^1, S, S^1, fig. 1 and fig. 2), the space between these curved bars and the stationary iron core being nowhere greater than is necessary to permit the free rotation of the wire cylinder. The curved bars are themselves prolongations of the cores of the electro-magnets (E E, E E); the sides of these two horse-shoe magnets (N, o—S, m and N^1, o^1—S^1, m^1) are connected by the iron of the two standards (O, m and O^1, m^1).

The coils of the electro-magnets form an electrical circuit with the wires of the revolving cylinder, and upon revolution of the latter a powerful current passes into the electro-magnetic coils, again exciting a still more powerful current in the wires of the cylindrical armature. The iron core of the cylindrical armature being very little distant from the poles of the electro-magnets, in proportion to the extent of opposed iron surface, becomes itself an intensely powerful transverse magnet of opposite polarity to the electro-magnet: the cylinder of wires thus revolves in a field of highest magnetic intensity. At each revolution of the wire cylinder, the maximum impulse in each convolution will be attained when passing through the middle of both magnetic fields, and will descend to zero when arriving vertical to that position. At this latter position will be a neutral line; and, according to the electro-dynamic law laid down by Lenz, a convolution starting from that line towards the north pole of the electro-magnet would be subject to a direct induced current; the opposite wire (continuing the convolution on the other side of the cylinder) will be traversed by a current of opposite direction—that is, opposite with regard to right and left-handed directions, but of a same direction as regards circuit, the opposite wire being subject to magnetic induction of an opposite polarity. This action will take place with all convolutions, so that the currents caused to circulate in each are of the same direction as regards circuit, but opposite in mere direction, at opposite portions of the convolution. As the currents are collected by the terminal rollers, or brushes (presently to be described), they present in the two halves of the cylinder, as separated by the magnetic neutral line, analogous poles to those of two batteries, supposing the two batteries to be connected in parallel circuit, to give a current of quantity.

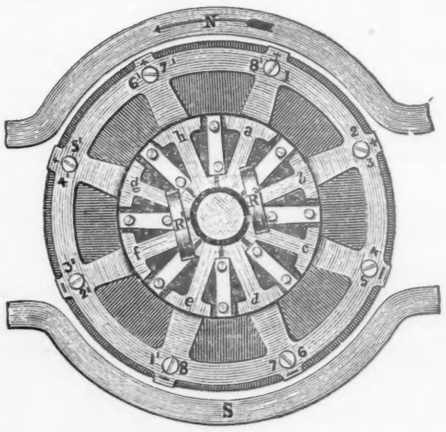


Fig. 3.

The circumference of the cylinder is divided into eight equal parts. Two such opposite parts are coiled one over the other, with *two* equal lengths of wire; the four ends of these wires being brought to the front end (a, b, fig. 2) of the cylinder, and connected to the eight metal sector springs (p p') of the commutator, these springs being electrically separated by strips of ivory, as shown in fig. 3. The several segments of coils of wire, however, form one continuous circuit (but not one continuous helix), being connected electrically at the sector springs, as may be seen by tracing out the connections, which show the following circuit:—

$+ 1 . f . + 4' . - 4 . g . + 6' . - 6 . h . + 8' . - 8 . a + 2 . - 2' . b . + 3 . - 3' . c . - 5 . + 5' . d . - 7 . + 7' . e . - 1' . + 1.$

The ends of the same length of wire are respectively numbered 1 and 1', 2 and 2', &c., and the signs + and — show the polarity of the electrical impulses of each wire (regarded by itself) as they arise, according to the momentary relative position, supposing the wire cylinder to be rotating in the direction of the arrow.

These electrical impulses are collected upon two metal rollers, or brushes—later investigations prove the brushes to be more preferable agents—so that at two points diametrically opposite the single sectors pass under the rollers, or brushes, with elastic pressure, yielding up to the latter their electrical charge.

It will be seen, when following the course offered to the current with the connections described, that all electrical impulses of the several helices will transfer to a sector, arriving at +, positive electricity, and to a sector, arriving at —, negative electricity; and that here the rollers to which the terminals of the instrument are connected must be applied to collect the electric current, which will be constant and continuous.

A slight increase of speed in the rotation of the wire cylinder effects a considerable increase of current. As the current increases so does the resistance to rotation increase, and renders necessary a higher driving power. This increase is very rapid. With increase of current there is also increased heat, and were it not for this increased heat one might obtain, with sufficient driving power, almost any amount of current. The heat developed at high speeds would overheat the insulation of the wire of the machine, therefore in continuous work the speed of the machine must not be taken too high.

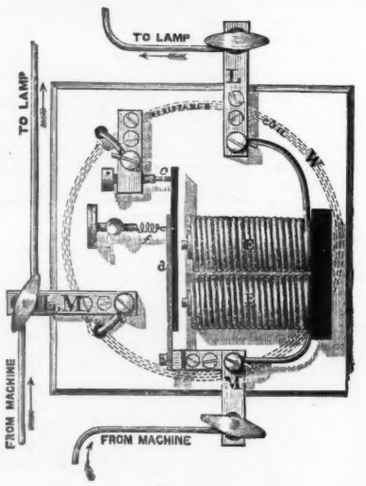


Fig. 4.

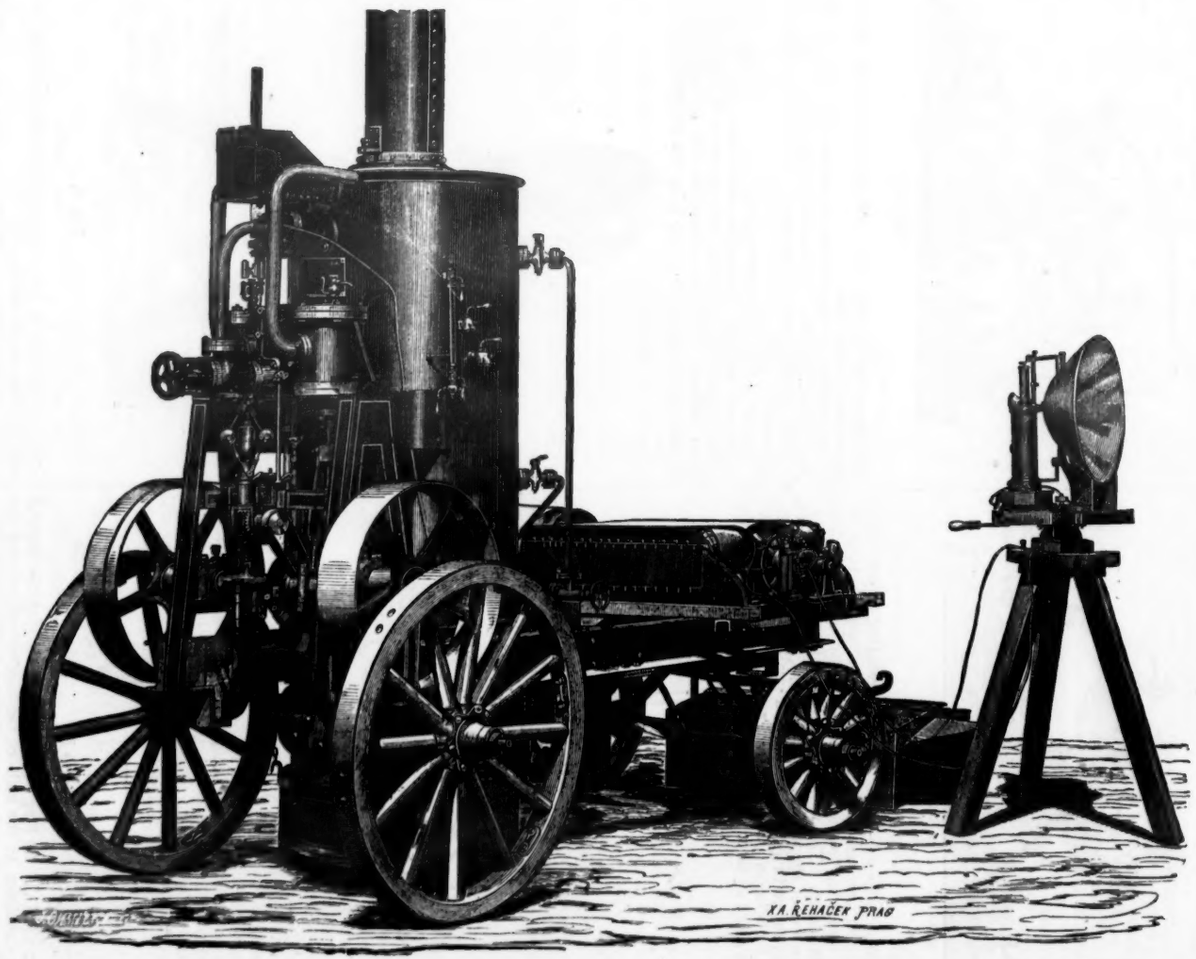
As the strength of the current also depends upon the exterior resistance (line, &c.) the speed should be slower, the smaller that resistance or the total resistance in circuit. With an electric lamp in a circuit of little resistance the wire cylinder, if the machine is intended to work continuously, should not make more than 370-380 revolutions per minute. The heating of the machine will then attain a maximum in about three hours, and will, during working, remain constant at that temperature. Water is not required to cool the apparatus.

The intensity of the naked light at this speed, the light being unaided by any reflector or lens, and as tested by a Bunsen photometer, has repeatedly been found equal to 14,000 normal (English) candles. This is believed to be the maximum intensity obtainable with the electric light, as a more powerful current splits and breaks up even the best carbons.

From the fact that a closed circuit revolving or rotating in a magnetic field experiences great resistance to its rotation, to which an interrupted or non-continuous circuit is not liable, motive power to any extent is required only when the machine produces a current, *i.e.*, when the circuit is closed. An interruption to the circuit, therefore, is equivalent to taking off the load from the driving engine, which, for purely mechanical reasons, would be dangerous to the engine, and for electrical reasons to the machine itself. For, when after the interruption of the circuit, contact again is made, the increase of speed that would have resulted in the meantime would cause a momentary current of dangerous strength which might be accompanied by burning sparks at the commutator, or other serious accidents.

For the production of a steady light it is requisite that the speed of rotation of the wire cylinder be as constant as possible. The driving engine, therefore, should be supplied with a trustworthy regulator, keeping the engine at a uniform speed however

XUM



SIEMENS' DYNAMO-ELECTRIC MACHINE.

pressure of steam and load may vary. It must essentially not permit too high an increase of speed as might result from temporary extinction of the light and removal of the load off the engine.

For greater security there has been constructed the self-acting shunt. This apparatus is placed close to the lamp and connected to both leading wires between the machine and the lamp, and the principle upon which it prevents extinction of the light being accompanied by interruption of the current may be

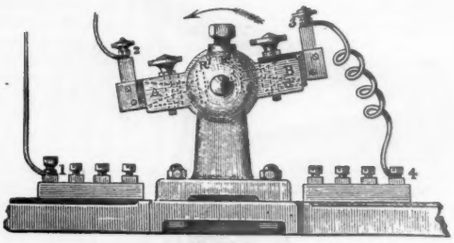


Fig. 5.

described as follows :—The terminal M (*machine*) is joined by a stout connecting wire to one terminal of the machine; the terminal L M is connected to the remaining terminal of the machine and to the lamp. The terminal marked L (*lamp*) is also connected to one of the terminals of the lamp. The details of the shunt are shown in fig 4. It contains a small electro-magnet E, with its armature *a*, a contact C and a resistance coil of wire W, which is about equal to the resistance of the electric arc of the

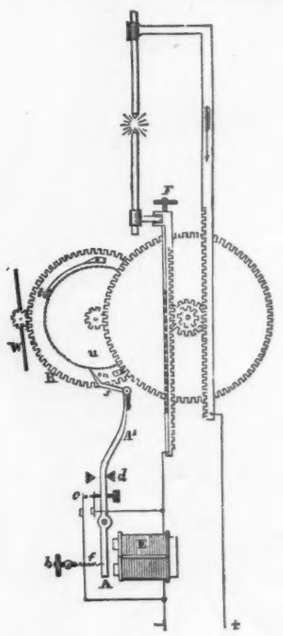


Fig. 7.

light (= 1 S. U.). As long as the light is burning the electric current circulates in the coils of the electro-magnet, and the armature *a* being strongly attracted interrupts the contact at C. The resistance coil W is, therefore, not in electrical circuit. Should the light be extinguished the current in the coils of the electro-magnet ceases, and the armature is withdrawn by the spiral spring *f* to the contact C. This offers to the electric current a path of equal resistance through W, instead of the lamp. The current of the dynamo-electric machine is, therefore, subject to scarcely any variation, and the driving motor has no cause to increase its speed. When, in consequence of the automatic action of the lamp, the carbon-points again touch, the current passes once more through the coils of the electro-magnet E, and the armature *a* is attracted, breaking contact at C, thus removing the shunt W from the circuit, and thereby re-establishing the former conditions.

The coil forming the resistance W is fixed beneath the base board of the apparatus, and placed inside a tin reservoir, which should be filled with water when interruptions of longer duration are foreseen than occurs with ordinary working, as, for instance, when it is inconvenient to stop the machine during the time of changing carbons. The water will prevent overheating of the

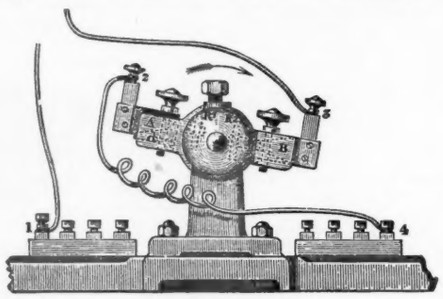


Fig. 6.

resistance coil W when under the influence of the full current for a considerable time.

DIRECTION OF ROTATION OF WIRE CYLINDER.—*Rotation from Right to Left, or in the direction opposite to the hands of a watch.* In this case the terminal 4 (fig. 5) is connected by a wire with terminal 3.

Under the piece of vulcanite (see figs. 5 and 6), carrying the right-hand roller R^2, is placed a small metal plate *d*, so that the roller R^2 may not be diametrically opposite the roller R^1, but a little higher. The whole movable arm carrying the rollers should stand slightly inclined from the horizontal position, so

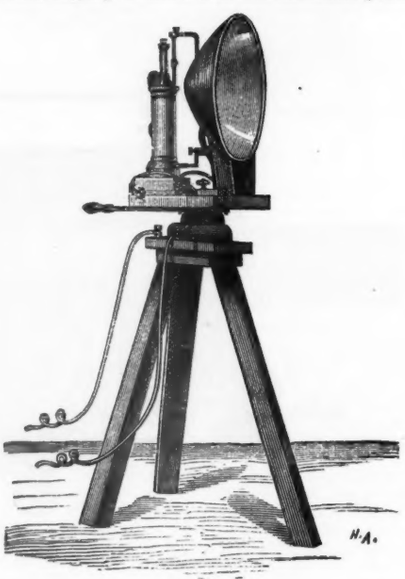


Fig. 8.

that its left arm A points slightly downwards while the right arm B points as much upwards.

The leading wires to the electric lamp are connected to terminals 1 and 2.

Rotation from Left to Right, or in the same direction as the hands of a watch. Should the direction of a motor pulley, or a given local circumstance demand motion in a direction opposite to that described, the following alterations are necessary :—

Instead of connecting terminals 4 and 3, the terminals 4 and 2 are to be connected by wire. The small metal plate *d* must be withdrawn from beneath the arm of roller R^1, and placed under the piece of ebonite carrying roller R^1, so that the latter roller may run slightly higher than the right-hand roller R^2. The arm carrying both rollers, which for the purpose is made movable

concentric with the axle, must now be inclined in opposite direction to its former position, so that the right-hand arm B shall stand slightly lower than the left-hand arm A. These changes are shown in the accompanying diagram, fig. 6.

The leading wires to the electric lamp are now to be attached to terminals 1 and 3. The directions—as right-handed or left-handed—are understood to be taken by a person standing facing the commutator.

Inclination of the roller arm is effected chiefly for the purpose of preventing sparks by reducing the sparking distance to a minimum. In case contact-brushes are used instead of rollers, special care must be taken that the machine be never turned in opposite direction to the arrow marked on the machine, or else the wires of the brushes will get bent and contact spoiled.

The conducting wires from the machine to the lamp should have very little resistance, and should be of copper, of high electrical conductivity. The section should be proportionate to the distance of the lamp from the machine. If the lengths of the two conducting wires do not together amount to more than 55 yards, and assuming the copper of high conductivity, a wire of 0·157 in. diameter will suffice. For longer distances, it is advisable to use a strand of larger diameter. Decrease in the strength of the current, caused by the introduction into the circuit of a conductor of too high resistance, may certainly be overcome by increased speed of rotation of the wire cylinder, but only at the expense of increased motive power.

Self-acting lamps have hitherto been constructed chiefly upon the basis of a clockwork action, employed to approximate the carbons to a certain point, when, by the influence of an electro-magnet, the clockwork being checked, the carbon points are allowed to burn away to such a distance that, consequent upon the decrease of current, the clockwork is again released, and the carbons caused to approach to their position of least distance.

The lamp here described is actuated *without* clockwork, which has always been a source of numerous failures and difficulties, and liable to disarrangement upon the least rough usage. This lamp also *distances* the carbon points when they have approached too closely or touch. By this united action of distancing and approaching, the carbon points are automatically kept at a uniform distance, and a perfectly steady light is obtained.

The working parts of the lamp are represented in the diagram, fig. 7.

E is the horse-shoe electro-magnetic motor, with the armature A opposite its poles. A spiral spring, *f*, the tension of which can be regulated by the screw, *b*, withdraws the armature from the poles of the electro-magnet, and brings its elongation, A^1, against the stop, *d*. When a current of sufficient strength to overcome the tension of the spring, *f*, circulates in the coils of the electro-magnet, the armature will be attracted, and contact established at *c*, which, offering a shorter route, diverts the current from the coils of the electro-magnet into the shunt. The consequent release of the armature from the poles of the electro-magnet re-opens the contact at *c*; the armature is again attracted, and the action is repeated during the use of the machine. When, therefore, the carbon points are so close that the resistance of the electric arc (of light) is sufficiently small to maintain a current in the coils just powerful enough to overcome the tension of the spring, *f*, the armature commences to oscillate, and continues to vibrate while the current is of the same intensity.

The spring-pawl, *s*, at the extremity of the arm, A^1, oscillating with the arm, actuates a fine-toothed ratchet wheel, *u*, in gear, by a train of wheels and pinions, with the racks of the carbon holders, and thus resists and overcomes the gravitating tendency of the upper carbon holder, slowly parting or distancing the carbons. Increase of resistance results from this distancing of the carbons, and the current becomes proportionately weaker; the armature ceases to oscillate, and again rests upon the stop, *d*.

In this position the spring-pawl, *s*, bearing its inclined face against a pin, *n*, is released from the teeth of the ratchet wheel, *u*; the preponderating weight of the upper carbon-holder now comes into play, and the carbons are approached to each other, the spur-pinion on *u* taking an opposite direction to that which it has when under the influence of the ratchet wheel. Increase of current follows the decrease of resistance consequent upon the decrease of length of the electric arc; the armature again oscillates: and this cycle of action is continuously repeated.

The speed at which the carbons approach is regulated by the fly W, the driving wheel R of which is fitted loosely upon the axle of the ratchet wheel, and coupled to this wheel by the spring detent *t*, the detent acting only when the carbons approach.

When in action the alternating movements of the carbons is scarcely perceptible, but when, by any exterior influence, the light is extinguished, the carbons immediately run together, ignite as soon as contact is established, and work apart under the action of the electro-magnet, to the distance determined by the tension of the spring *f*.

Too slack or too little tension of the spring would cause the electro-magnet to separate the carbons too widely, thereby, extinguishing the light and producing a flashing light, burning, extinguishing, and re-lighting at regular intervals. If the spring be too taut or at too high tension, the carbons would not separate, the electro-magnet remaining inactive.

Besides its two-fold application the lamp commends itself for compact and simple construction, as well as for great precision in regulation. This capability results from there being no two positions of rest for the armature; the strength of current, depending upon length of the electric arc, is determined by the *one* momentum of attraction to which the withdrawal always immediately follows automatically.

Two kinds of concentrating apparatus are supplied in combination with the automatic lamp. The *parabolic* reflector is of stout plated copper, inside brightened. The apparatus is mounted upon a wooden stand, as shown in fig. 8, and can be directed to any point by means of a ball-and-socket joint. A *Fresnel dioptric lens* may be substituted for the parabolic reflector. This lens is too well known to need description. It is contained in a metal case, inside which the lamp is placed upon a slide, to admit of obtaining the focus. The entire lamp revolves horizontally upon rollers, and swings upon pivots, to obtain any desired inclination. Both apparatus are provided with a lens, by means of which an image of the burning carbons is thrown upon a small screen of frosted glass; the carbons can thus be easily adjusted without fatigue to the eye.

For military and various other purposes, the Dynamo-Electric Light Apparatus is mounted on a waggon, with complete steam engine, the total arrangement weighing 2,250 kilos. (4,960 lbs.). The boiler of the engine is made of steel; the engine, which is of 10 h.p., has two cylinders, and a very steady regulator. The frame of the waggon is mounted on springs. The spindle of the engine can make as many as 200 revolutions per minute, which corresponds to 450 armature revolutions of the Dynamo-Apparatus. This combination of steam engine and Dynamo-Electric Light Apparatus has proved very serviceable, on account of its facility for transport, its compactness, and small weight.

Numerous experiments have been made with a view of testing the comparative merits of the various electro-magnetic light machines that have been invented, and they have resulted in the fact that Messrs. Siemens' machine produces the most powerful light at the least cost.

THE ECONOMICAL PRODUCTION OF STEAM.

THE public trial of Mr. James Reilly's patent casing and seating for steam boilers took place at the patentee's chair works, adjoining Pomona Palace, Manchester, on Tuesday and Wednesday, August 15th and 16th. The experiments, which were conducted under the superintendence of Mr. W. Ashton, C.E., of Cathedral Yard, Manchester, were witnessed by a number of scientific and practical gentlemen interested in the subject. The experiment was commenced at 10 a.m., and concluded about 6 p.m. each day. The water was evaporated at atmospheric pressure, and escaped from the dome of the manhole by a 9-in. pipe. The feed water was measured in a tank of 1 cubic yard capacity, and the coal was weighed in barrowsful as required. The results were highly satisfactory, and exceeded, it is believed, any hitherto recorded. Details are appended below:—

	Aug. 15	Aug. 16
Duration of experiment in minutes	475	455
Lbs. of water evaporated by 1 lb. of coal:—		
At feed temperature	11·21	12·12
Calculated at 212° Fahr.	1278	1378
Cubic feet of water evaporated per hour from feed temperature	44·33	37·51
Total lbs. of water evaporated	21,931	18,557
Total lbs. of coal consumed	1,956	1,530
Lbs. of coal consumed per hours	274	201·75
Lbs. of coal consumed per hours, per square foot of grate	10·3	8·4
Lbs. of ashes at close of experiment	248	111
Average temperature of feed water	76·5	79
Area of grate surface in square feet	24	24
Temperature of escaping waste gases	316	280

Fires about 4 in. thick, and coal spread evenly over grate at each firing.

Coal used: Oldham Black Mine burgie.

A NEW REVOLVING FURNACE FOR TREATING ORES, ETC.

AS a substitute for the various means now employed for removing sulphur, antimony, arsenic and other volatile substances from ores by roasting, and the smelting and reducing of same in stationary furnaces, we illustrate in this issue an improved revolving furnace invented by James Manes, of New Haven, Connecticut. We will first describe the furnace and then give Mr. Manes' process for handling ores.

Fig. 1 is a perspective view of the apparatus; fig. 2 a longitudinal section of the furnace as used for roasting ores; and fig. 3 a transverse section of the invention arranged for smelting purposes. Referring to fig. 2, A is a sphere of boiler plate or cast iron, lined with ganister, fire brick, and asbestos, the effect of which lining is to keep the exterior of the sphere cool, even while an extremely high heat is maintained within. This globe is suspended on hollow journals, and on its exterior surface are circular racks, B, which engage with the gear wheel, C, and the latter communicates with the hand wheel, L. By turning this hand wheel the globe is easily rotated. E is the furnace, the blast from which enters the globe, which is previously filled with ore and closed, through the water tweer, F, which passes through one of the hollow journals. During the operation of roasting, the globe is constantly rotated, so that the ore within is kept in agitation, thus allowing the heat to pass through and act upon every part of its mass. The volatile products make their exit

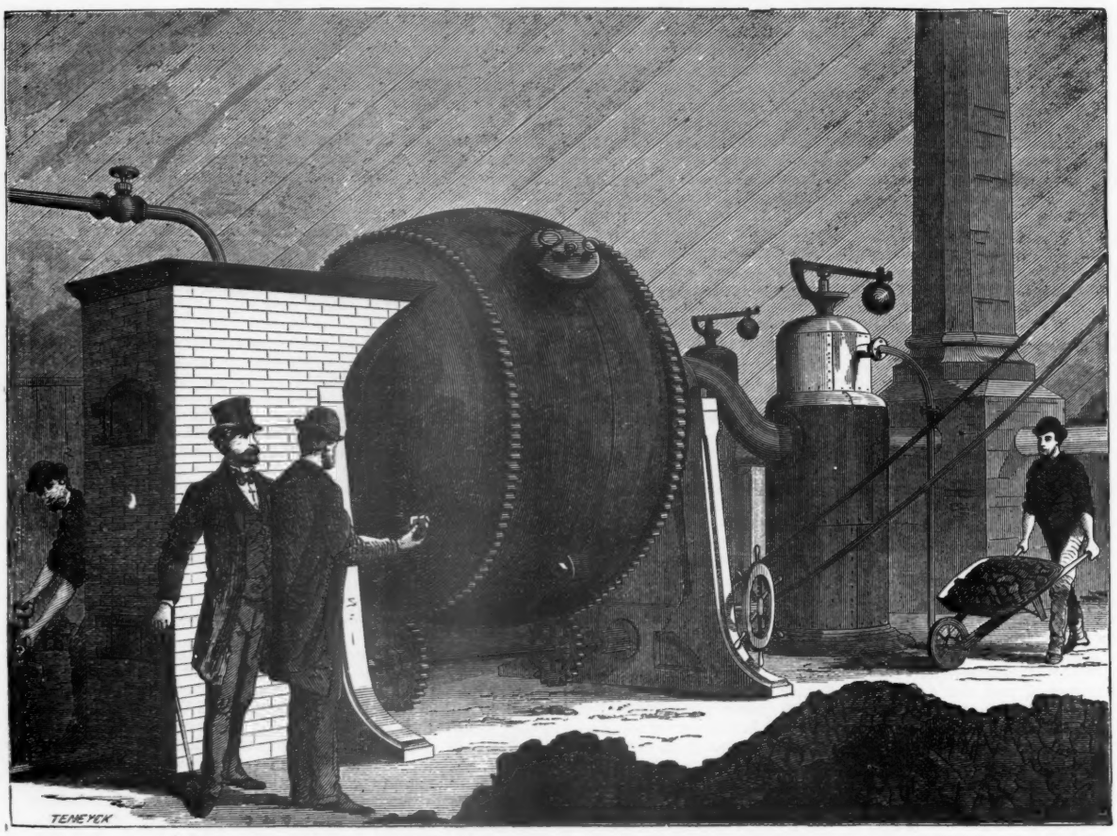


Fig. 1.

through the opposite journal, G, and entering the condenser, H, are condensed by a fine shower of water entering through the perforated diaphragm, I. In this way such materials are reduced so as to be easily removable; and at the same time, if precious metals be under treatment, such portions of the latter as would otherwise escape are caught and retained. From the condenser the blast passes, as shown, into the chimney.

The adaptation of the furnace for smelting purposes is easily understood from fig. 3. The globe is of course held stationary during the operation; and the blast, entering by water tweers through both journals, passes down through the charge, is reflected up, and exits through the open man-hole above. The tweers can be continued downward and entirely around the bottom of the globe, if required. When the process is complete, the globe may be tipped to discharge its contents through the man-hole at J, or it may remain stationary and the charge be removed through the vent at K.

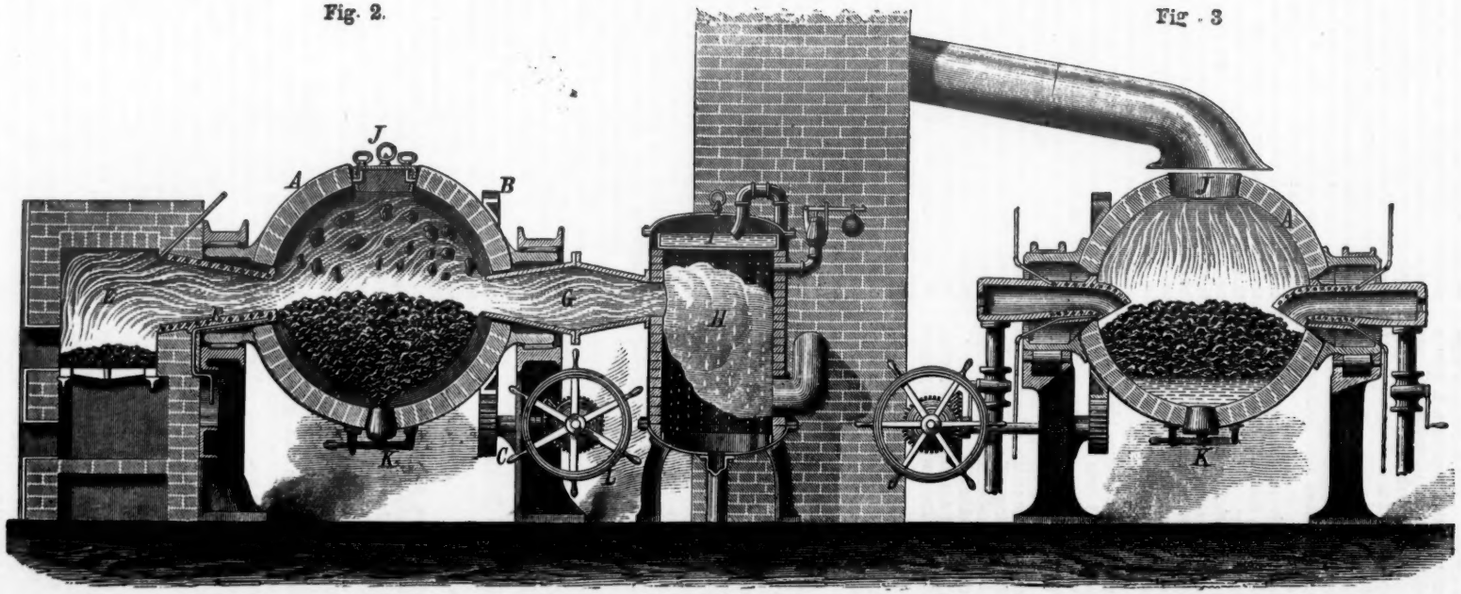
PROCESS OF HANDLING REFRACTORY GOLD AND SILVER ORES: FIRST PROCESS.—The ore is first crushed or stamped to a powder and 25 per cent. of fuel and 1 per cent. of black flux mixed with it. When so treated the powdered ore, to the amount of one ton or more, is put into the furnace (fig. 2) through the man-hole, J, which is then closed and the furnace started. The charge thus introduced will be thoroughly desulphurized in one hour or less, and the arsenic or other impurities carried off. The chemically prepared amalgam is next added which takes up all the precious metals in a very short time. After this the charge may be removed to the settler or washing machine where all the earthy matter is removed, and the amalgam left ready for retorting, when the work is completed.

For handling refractory and low grades of gold and silver ores, the inventor claims for the apparatus special advantages, as by its use several tons can be worked daily, and the labour of but one man to attend the furnace will be required. The globular form adopted is one easy of construction and well suited to sustain its great weight from two points of support. The lining of the interior can also be rendered more stable than in any other form, while it presents less surface for the radiation of heat.

SECOND PROCESS.—If gold and silver ores must be smelted they are first desulphurized, the same as in the amalgamating process, and mixed with 20 per cent. of fuel (coke preferred) and 1 per cent. of red flux. The charge is then placed into the

Fig. 2.

Fig. 3



NEW REVOLVING FURNACE FOR TREATING ORES.

FIG. 2.—LONGITUDINAL SECTION.

FIG. 3.—TRANSVERSE SECTION.

furnace (fig. 3) through the man-hole, J. The furnace having been previously heated to a dull red colour, with five hundred pounds of lead at the bottom, it should be kept going at a very gentle blast until the whole is melted. The furnace is then tipped over with the lever wheel until the man-hole, J, is in a horizontal position. The cinder is then skimmed off, one hundred pounds of zinc added and mixed thoroughly with the melted mass, and it will take up the gold and silver which can then be skimmed off and retorted.

Many of the ores hitherto found most difficult to handle, such as nickel, cobalt, antimony, arsenic, zinc, &c., can be safely worked in this furnace, as no injurious fumes save such as pass through the condensers can escape.

The following are a few of the many important purposes, besides the treating of gold and silver ores, that the Manes revolving furnace can be practically used for:—

Making wrought iron direct from the molten iron of the blast furnace or cupola. Also, malleable iron castings that require no annealing and can be worked under the hammer.

To make several grades of steel without the aid of crucibles, thereby saving the great amount of labour and expense now required for this purpose.

Refining, alloying and mixing metals of many kinds; also, oxidizing lead and zinc very rapidly and at little cost.

Extracting mercury (or quicksilver), antimony, arsenic, zinc, bismuth, cobalt, nickel, lead, copper and all other metals from their ores.

Making gas from coal or other materials; also, coke and coal for smelting purposes; and the washing of coal and other minerals to free them from sulphur and other impurities.

Distilling and purifying mineral and other oils.

Rendering or extracting lard, tallow, or any other fatty matter.

Mixing mortar and concrete for building purposes, laying of roads, &c.

This furnace can be used for a great many other purposes too numerous to mention here. It is destined to come into very general use throughout the United States and foreign countries.

A great amount of labour is saved by its use in all the various purposes for which it is so well adapted, and it is without question one of the most complete labour-saving inventions that has ever been brought before the public.

The first one of these furnaces is being constructed by the Hartford Machine Company for the new nickel smelting and refining works of Hartford, Connecticut. Four complete furnaces of like pattern are to be erected in these works.—*Philadelphia Iron and Metal Review.*

SANITATION.—WHAT IS TO BE PRACTICALLY DONE IN CONNECTION WITH IT.

No. II.

IN the first of our papers, vol. v. p. 112, we drew attention to the importance of the *site* of the house, as exercising a very remarkable influence upon the health of its inhabitants if certain points connected with it were not attended to, and we very briefly pointed out what these were, and how they could be met, in a practically useful way. We would now in like brief manner draw the attention of our readers interested in this great question of sanitation—and who is not? for without wishing to perpetrate a pun, it is one which comes *home* to every one,—to other points as important as the site; and this may be said of all the details of sanitary construction and arrangements of houses,—that none can be dispensed with, all are important.

But before proceeding to these we would add to those remarks we have already given on the site of the house, a few bearing upon a point too frequently neglected, and that in close connection with it. And this is, the finishing off of the surface of the soil which is to be immediately below the flooring of the various apartments. Of course it need scarcely be said that we utterly condemn the system of laying the flooring in close contact with, or even a few inches above, the surface of the soil, in the case of first-floor apartments. In few cases, excepting the floor of the kitchen, scullery, and lobby, is the plan of laying the flooring surface immediately upon, or in actual contact with the soil, adopted, and that only, as a rule, where stone flagging or tiles are used as the flooring material. But even in such cases and with such materials we would most strongly recommend that a cavity or space of considerable depth be left between the upper surface of the soil and the lower or under surface of the flagging. If this be used, by far the best plan to ensure a dry floor would be the placing of the flagging upon brick bearing walls or sleeper walls, and in the case of tiles, these should be made to rest upon a layer of dry cinders or clinkers of considerable depth. But however well suited for the flooring surfaces of lobbies flags or tiles may be considered, we have a strong belief that neither of these is suited for apartments in which work is to be done or people are to live, such as washhouses, sculleries, or kitchens. They give at the best but a cold comfortless surface, and although it is too often the case that anything is deemed good enough for the workers, the "helpers" of a house—as the Americans designate our servants—we are not of those who believe this; quite the contrary; and seeing that they have, as a rule, by no means the maximum share of the comforts and domestications of life, it is but right that all which can be done should be done to make their lot as light as possible. We must strongly urge upon the builders of house property to see that their working and sleeping apartments—upon which we shall have hereafter a word to say—be as comfortable as possible. Let, then, good boarded floors be given to the kitchen and working apartments, so that cold surfaces, upon which servants have to stand so long, as in the washing-house and scullery, or go over so frequently, as in the case of the kitchen, be avoided.

In the case of the superior apartments of the house, let the utmost care be taken to secure a dry under-surface below the floors. By far the most effective way in which to secure dry floors to these rooms is to have them cellared under. These cellars so formed will be also exceedingly useful for many household purposes, such as the storing away of provisions, keeping of beer, wine, &c. Where the expense of these under-floor apartments, however, is objected to—as objected to it often is, although with what reason we fail to see, as we consider a cellar to be as essential as any other room, on the score of the convenience it affords, to say nothing of the part it plays in keeping the house dry—let a greater amount of care be observed in seeing that the soil underneath the ground-floor rooms be in a healthy condition. Few have any conception as to the state in which the soil is often left below a drawing-room or a breakfast-room floor. No wonder that smells are complained of as "coming up through the boards for which we cannot account, you know." If the boards were taken up in such cases the smells—and something else—could easily be accounted for. The way in which the spaces under the floors are often left by the workmen is highly culpable. Wood shavings, oily rags, pieces of wood, and other things besides, are left to rot and fester below, and send up through the chinks of the floor all manner of smells marvellously foul. And more than this, and worse than this, drains are sometimes led right across the site and through and under the floor soil; and these, getting out of repair, add a thousandfold to the evil condition of matters. "But," we can fancy some of our readers exclaiming, "surely this last atrocity is never perpetrated!" Well would it have been for many families, well would it be for many now, if it never had been or never was done. But the records of our sanitary papers, and the too many newspaper paragraphs, show too truly that this shameful thing is one of "the things" too often done; and not only in the case of the houses of the poor, but also in those of the well-to-do, and not quite unknown in the mansions of the highest of the land. Let us, however, hope that *this* evil will soon be amongst the things of the past; but we fear it will be long before the other evil we have alluded to becomes so. It is, nevertheless, one which ought not to exist in a well-constructed house.

The soils below all ground-floors should be taken out for some depth—the deeper the better—and the excavation filled up with dry materials as non-absorbent as possibly can be got, such as cinders, smelters' clinkers—the more vitrified the better—pieces of broken gas retorts (earthenware ones we mean, of course), or the slag from ironworks. And even when this is done—and of course much more when it is not done—in no case should the flooring joists be placed in contact with the soil or with those materials, but a space in all cases left. Where the best—we were about to say the most perfect—method of finishing the surface of the soil below ground-floors is desired, the whole surface should be covered with a layer of Portland cement concrete. This, which is now being largely introduced for paving and flooring surfaces, is almost wholly impervious to damp, is non-absorbent, and so hard as to be completely vermin-proof. If, in addition to the soil beneath the floors being laid with this concrete, it passed under the foundations—or rather, if they were built upon a layer of it, extended for some few inches beyond the wall,—we could scarcely conceive of a house being damp.

As bearing very closely upon the subject of the soil of the site of a house in relation to the health of its inhabitants, it will be worthy of the attention of our readers to note the researches made by eminent savants as to what may be called the aerial condition of our soils—thus a gravelly soil has been found to contain one-third of its bulk of air—and that the air of soils is highly charged with carbonic acid gas. Taking the proportion of volumes of this gas at six to each ten thousand volumes of what may be called the atmosphere of a house, as yielding what may be taken as the standard of healthy air to breathe in it, some idea may be formed of the highly unhealthy condition of the air of soils, when we state that Boussingault showed that in some soils the proportion had risen to so high a figure as nine hundred and seventy-four times of carbonic acid gas to ten thousand of air, some two hundred and twenty-one, some one hundred and seventy-nine, and some ninety-six. Now, when we consider the comparative ease with which gas is drawn, so to say, from and through a soil, and this draught is exercised so strongly that the gases are drawn from comparatively great distances, and further when we consider that this drawing power is greatly aided by the action of fires in apartments, we can easily see the importance of attending to the state of the soil below and surrounding our houses, so that none of the "evil conditions" too often attendant upon soils, some of which we have named, shall exist, and that all means be taken to prevent their acting—if they do exist—injuriously on the health of those who live in the houses built upon them.

Having thus thrown out a few hints in connection with the important department of the site of houses, we now proceed to the consideration of other departments, and the first we shall concern ourselves with will be the building of the walls, or rather certain points connected with these, for with the practical details of building many of our readers can have no acquaintance, however much they are interested in knowing that they be soundly, and what is to the point at present, healthily constructed. We have in our first paper drawn attention to the influence which damp exercises upon the health of those living in a house affected so to say by it. Now, a very commonly met with source of damp is the walls, and this arises first, from the way in which their foundations are made, and secondly, from the way in which the superstructure or upper parts of the walls is or are built.

First, as to the foundations: much of the damp which is found in walls would be prevented if the site was thoroughly drained, as recommended in the first of our papers, and this as a preventive is, perhaps, one of the most to be relied upon, and if effectually carried out, no other need be tried. Still, in order to make sure work, it will be well to lay the foundation above a bed of concrete—which may either be of the ordinary kind known as lime concrete, or of that as cement concrete, to which reference was a short space above made. This precautionary measure is all the more essential to be carried out in clayey and retentive soils, for however well they may be drained, a good deal of wet flows in from the surrounding soil, and attacks the foundation. And unless the roofs are well guttered, the drip from the eaves falling as it does so close to the walls, runs down and comes in contact with the foundation. The concrete therefore, of whatever kind used, should not be merely of the breadth of the foundations, but should extend beyond them for some inches outside. And in addition to these measures it will be all the better if a "damp-proof course" is laid round the whole range of wall. This is generally made either by building-in a course of slates, or a sheet or strip of lead, or by spreading a layer of tar, the height at which these materials are laid being some few inches above the ground level. Hollow or perforated bricks—in the case of brick walls—are also becoming extensively used as damp-proof courses. But in all the object is to prevent any damp which the foundation and lower courses may gather from the soil, reaching to the upper courses, and through the whole wall in the course of time, which it is sure to do if once it fairly gets possession so to say of the foundations. It is impossible to err in being too careful in the construction of the foundations of a house; not only should they be of the proper and full width, carefully bedded on good concrete if the character of the soil demands this, as already stated, but of solid work throughout, no broken bond in the bricks should be allowed, or mere facings of stone—if this be employed, the interior being filled up with any sort of rubbish or grouted with poor mortar—such work will never be satisfactory.

As regards the walls themselves, we may here draw attention to a point which is much discussed, namely, the inferiority of bricks as compared with stones, the first by many being supposed to give a wall peculiarly liable to damp. Now we believe that if a fair and a very wide survey was made of the houses throughout the country, there would be found, as a result, that the greatest number of damp houses are those built of stone. Taking like qualities or standards of each, brick is less absorbent than stone, and if not so, it possesses this advantage, that there are greater chances in favour of its drying much more thoroughly and quickly than stone. When once stone of such qualities as are generally used gets thoroughly saturated with damp there are very few chances in its favour of becoming thoroughly dry again. No doubt there are some kinds of stone which do not so readily take up the damp, but even these, when once they become so, are long in becoming dry. Much also depends upon the way in which stone walls are built, for not seldom they are, as hinted at above in connection with foundations, mere sham-built, professing to be thick walls, and with all the thickness made up of solid stone well bonded with "throughs" at proper intervals, but merely professing to be such, for the facings are only what the wall professes to be throughout the interior. To make up the thickness, which is boasted of by the builder and trusted to by the employer as giving thickness, and therefore warmth, strength, and immunity from damp, the interior is filled up with stone shivers, or poor quality of rubble work, and grouted with mortar too often of a poor quality also. Now this honeycomb wall is a mere deception, and if once the interior gets saturated with damp, farewell to the dryness of the outer, or what is worse the inner faces. There are some qualities of stone so absorbent—being so porous and full of small cells, so to say, that they suck up water like a sponge, and the cells, as we call them, retain the water—that there is little chance of a wall built of it being a dry one for any length of time, the first wet winter doing mischief which several dry seasons will not undo, and this even in cases where the walls are honestly—that is, solidly—built. Stone of such qualities should never be used, and it will be worth the exercise of a little trouble to ascertain, previous to using any stone, what are its characteristics. There is a very useful table published in the majority of building works showing the absorbent qualities of a great variety of building stones, this being the result of a Parliamentary inquiry. A good precaution in stone walls, and also in those of brick, is having them built as "cavity" walls, that is, with a hollow space in the centre of the wall. Damp from the outside rains will not penetrate, or at least will not reach so quickly the inner face if the walls be built hollow thus. Brick affords greater facilities for the formation of cavity or hollow walls than stone, and a wall which, as an ordinary 9-in. one, would be liable to be damp, built as an 11-in. cavity wall, has a very good chance of being dry. Much of the prejudice which in some quarters exists against brick walls arises not only from their being too thin—a 9-in. solid in place of a 14-in. solid, or a 9-in. solid in place of an 11-in. cavity, for example—but much more frequently from the choice of badly burnt, porous, unsound bricks, and from the scamping way in which they are put together—broken bricks, imperfect bond, and mortar of the poorest quality, which crumbles away in a season or two. An honestly built brick wall of good sound, hard, well-burnt bricks, even if only 9-in. in thickness, will be worth far more than a 14-in. or even a two-brick thick wall dishonestly built. It is most mistaken economy to use bad bricks simply because they are cheap, and mistaken policy in building to build quickly. Expense may at first sight be lessened, but it will not be long before the proprietor finds out his mistake in incessant demands upon his purse for repairs, or of finding those worse demands upon the health of those who have the misfortune to live within such walls, so thoroughly badly built at the first.

Another advantage which brick possesses over many qualities of stone—which it may be as well to name here, although it is a quality connected more with the safety than perhaps the sanitary condition of property—is its capability to resist the action of fire. In many cases of fire the walls, or parts of them if built of stone, are rendered wholly useless even when the fire has not been a very bad one or a "thorough one," from the stone either exfoliating or crumbling to pieces under the action of heat, this being more specially observable in the case of limestones. But walls of brick will often scarcely be injured by a fire of the same degree of intensity, and may be allowed to stand with perfect safety, while the stone ones would have to be rebuilt. This was most strikingly exemplified in the great fire at Chicago, in the United States, the stone houses there, being mostly built of a kind of limestone, were nearly all totally destroyed, the walls crumbling away and breaking completely up—the same with the iron houses; but those of brick stood the intense heat so well that the walls in many instances were left sound. Indeed, several instances showed an unusual quality in brick, namely, the power to resist fire, that is, not to be so easily caught up by surrounding flames. A very remarkable example of this was noticed in the Chicago fire: a brick house, situated in the very midst of a burning district, surrounded on all sides by the flames and heat of burning houses, was, to the surprise of all, when the mass of fire had burnt itself out, found to be still standing, and, what was very remarkable, it had not taken the fire at any point. There

is, we believe, much to be learned yet in the direction of safety from fire to be gained by the use of building materials for the external walls. We understand that the Chicago experience is to be made the subject of a special report upon fires, from which much may yet be learned.

Where the misfortune exists of a thoroughly damp wall, it is not only a difficult but a costly thing to render it dry. All sorts of expedients have been introduced and numerous materials have been patented by which damp walls can be made and kept dry. External coatings of tar, although to a certain extent efficient, yet rendering the house exterior hideously ugly, are employed, but these require to be perpetually renewed; coverings of slate, also external and little less ugly, are also used; or cement, which is not so ugly, but which, if not honest in quality and in the way it is applied, is very costly, as it lasts no great length of time. Then again there are a host of linings for internal use which at first, most of them, show signs of efficiency that, unfortunately, do not last long. Although, perhaps, the most expensive, we believe that no expedient will equal, not only in efficiency but also in its lasting characteristics, an application externally of Portland cement, that is if the quality be good. Perhaps the best test of this is its weight per bushel, which should not be less than 100 lbs., all the better if it is 110 lbs., or at all events 100 lbs. Of course all external applications of whatever kind must be or should be made at a season of the year when the walls have had as long a part of the drying season as possible, and should never be applied when the surface is wet. But some walls get so thoroughly saturated with damp that it will require a very dry season indeed before the external application can with safety be given. For rural or suburban houses, in place of the ugly coating for external walls of tar or slate, ivy may be used with picturesque effect, and will be found a capital thing to beat off driving rains. We are quite aware of the fact that the popular notion is, with respect to this plant, that it makes a wall damp upon which it grows. It is not so. Examine a wall which is covered with ivy—we mean, of course, a pretty vigorous growth of it, after days—nay, a whole season of rainy or damp weather, and you will invariably—we never yet saw an exception and we have tested many and still test all examples we meet with—find the wall below quite dry. The fact is, one has only to examine the habit of growth of the plant, to see that the rain, however strongly it may be wind-dashed against the leaves, cannot reach the wall through them. The leaves dash off the rain and cause it to drip downwards, but it cannot pass under the leaves and of course not through them, neither can it nor does it pass from above a leaf, for each leaf is more or less covered with the overhanging part—armour fashion—of a leaf above it. Then again ivy has this advantage, that while there is a close armour of leaves, the branches are so numerous and so singularly placed in relation to the leaves and to one another, that the space, as it were, of the covering is honeycombed, so that the wind and air can get freely up through and amongst the "panoply of green and dry;" thus acting upon the surface of the wall and keeping it dry. Ivy has thus a two-fold advantage; it may harbour vermin, but it is not so much of a nuisance in this way as it is supposed to be, or as many other plants are; and it always looks well with rural surroundings. We believe that there are, however, other plants which would give an equally pretty effect with much of the damp preventing qualities of the ivy; but the difficulty is in their not being evergreen. Some of the evergreens trained to walls have not the same fine adaptation of leaf surface and branch disposition which makes ivy so valuable for the purpose here under consideration. And then the interior has to be or ought to be also dealt with as well as the exterior surface. It is very unpleasant to have the reputation of being invidious in the naming of any one material used for constructive purposes where there are many offering themselves to public notice, but we have found a material, to be had of Messrs. Jackson and Graham, London, to succeed when everything else which had been tried had failed. For the thoroughly saturated parts of interior wall surfaces—and we have examined such in an actually dripping, not moist, but absolutely wet state—the only true remedy, we are inclined to believe, is the application of Portland cement. The expense of this is often lowered by using a heavy proportion of sand, but the proportion of this should never exceed three parts to one of the cement, which—and we cannot too often name this—should be of the finest quality. There is a variety of what are called damp-proof papers used for lining the interior surfaces of walls, but for our part we have as yet not met with one quality which deserved its name. After all, the best thing is prevention, and the way to secure this is to use the best materials, and to build them in the best way, and it is only in the case of walls already built that curatives or so-called curatives are to be used; but there are some walls so bad that they never will be cured, except in the fashion of curing a bad leg by cutting it off, that is by pulling down the walls and putting up good sound ones; in point of fact, there are some houses so damp they are not fitted for "habitations for humans." We may not live to see the day, but we believe under more enlightened views as to what sanitation is, and how it should be carried out, that the day will come when a damp house will be looked upon as as much of a nuisance as some nuisances are now looked upon, not being fitted nor to be allowed to exist, and will, therefore, be simply swept off the face of the earth. There are hundreds of damp houses now existing throughout the kingdom, which are as surely killing their inhabitants, or rendering their lives miserably unhealthy, as any condition of defective or thoroughly neglected drainage or sewage, or overcrowding. A lodging-house—under the Act—is not allowed to be over-crowded, why should a thoroughly damp house be allowed to be inhabited? The answer is obvious, in the one case the effects of the evil are more immediate, more easily seen, and, we should say, more thoroughly and widely understood than are those of the other, which are not seen or obvious, being on the contrary so exceedingly insidious and occult, and we regret to have it to say, not at all thoroughly and widely understood even by medical and high sanitary authorities—that is if we are to judge from the way in which the subject is considered and dealt with, or seldom, we should say, not considered and not dealt with. Well would it be for those who are compelled to live in thoroughly damp houses if this were not the truth, as truth it unfortunately is.

NOVEL METHOD OF SECURING STEREOTYPE PLATES.

ADOPTING the axiom of Lord Bacon that "every man is a debtor to his profession, from the which, as men do of course seek to receive countenance and profit, so ought they of duty to endeavour themselves by way of amends to be a help thereunto," Mr. Richard Clay, jun., after numerous experiments extending over several months, has just brought to completion a most ingenious method of securing stereotype plates—one which supersedes the use of chases, side and foot sticks, quoins, &c. Stereotype-printing has now assumed such important dimensions that anything which promises to facilitate the printing of stereotype editions of books is a matter which deserves the best consideration of the master printer. We therefore think our readers will be glad to learn the *modus operandi* pursued by Mr. Clay.

Usually, stereotype plates have been either mounted on mechanical blocks, such as the French metal blocks, or upon wooden blocks. These involve considerable trouble in making up and underlaying, and the plates are frequently seriously damaged by the pressure of the catches on the edges bending and breaking pieces away. With narrow margins, also, there is great difficulty in finding sufficient space for the catches; moreover, the amount of waste from breaking up leads and furniture is very great, as all master printers know to their cost.

We do not overlook the fact that a plan has been patented by Mr. Tickle which is ingenious, and in the hands of careful men is perhaps workable, but it is open to the same objection of difficulty with narrow margins; it is also expensive in first cost, and slow; and, above all, is not always safe. Mr. Clay's new plan is entirely different in a most essential particular, and while no chase or furniture is required, all difficulty with narrow margins is also overcome; damage to the edges of the plates is prevented; and the process of underlaying is accomplished perfectly and without trouble.

Let us proceed to describe the method in detail. Ordinary blocks are replaced by an iron bed, sufficiently large to take in a form of, say, 16mo. This bed is merely a plain iron surface, of the height of ordinary stereo-blocks; it is covered with a cement, and the plates are simply fixed on in such a manner, to be presently described, that the cement forms an air-tight joint all round the edges, so that the plates are held in their position almost entirely by atmospheric pressure.

An ordinary press with the tympans taken off is placed with its table level with a steam-chest, which is about the same size as the table of the press. An iron table is placed on the other side of the said steam-chest, also level with it, so that the three surfaces are uniform—that is to say, the press, the steam-chest, and the iron table. The iron bed is first placed on the steam-

chest to be warmed; it is then coated by a brush with cement, and removed to the iron table, where it is allowed to cool. When quite cold, the stereo-plates are placed upon the dry cement, and adjusted in their places. In order to do this accurately, a light wooden frame is laid over the iron bed, with cross threads stretched at proper intervals to mark the margins. This frame is of such a thickness that when laid over the iron bed the threads are raised a trifle above the surface of the plates. The plates having thus been adjusted or gauged, the iron bed is again pushed on to the steam-chest, and as soon as the cement is melted, the bed is shunted on to the bed of the press. Loose sheets of paper are laid over the plates to soften the impression, and the table is run in under the platen. The pressure is applied until the cement is cold, when the table is run out and the forme is ready for the printing-machine. It is found in practice that the stereotype-plates are held perfectly safe for either cylinder or flat-pressure machine. The cement runs round the edges in such a way that not only is the plate secured by atmospheric pressure, but by the ridge of cement formed all round each plate. The cement also runs *under the plates*, where they are at all thin, and thus forms a perfect and exact underlay precisely where it is wanted.

A great deal of time and trouble is saved to the machine-minder in consequence of this fact, as the formes are given to him level, and definitely gauged up, so that he has nothing to do but fix his stereo-beds in their places on the machine, and overlay, as with a forme of type. The forme cannot spring, and the rollers can be worked to a much greater nicety than with ordinary blocks, the surface being quite level; neither is there any danger from furniture or leads being drawn out.

Mechanical blocks are very open to the objection of being damaged and made useless by dirt and carelessness; not so Mr. Clay's new beds. There is no delicate mechanism to damage, the iron beds not being liable to injury, while it is also found by experience that a great saving of time is effected at machine by their use.

We believe that stereotype-plates have been occasionally fixed on blocks by cement, yet this process, as now carried out is, as our readers will admit, quite a novelty. The method of getting the plates accurately in their places by means of the threads and frames may seem open to objection, but is in fact so simple and expeditious, that prejudice on that point soon vanishes on practical demonstration of the process, which, in truth, may be said to comprise nothing more novel than the steam-chest and the stereo-beds, which are of course planed perfectly true on the top surface; the under-part being also planed, but not solid. The cement used is composed as follows:—

Beeswax	1 lb.
Gum Thus (Rosin)	1 „
Burgundy pitch	1/4 „

If this is found to be too hard, additional wax or pitch may be added.

Mr. Clay has tested these beds in every possible way, and has found them invariably secure. We have ourselves personally inspected the whole process, which we confess we were not at first prepared to think feasible. We are bound, however, to admit that the objections we had anticipated in regard to the security of the plate and the gauging of the forme do not seem to arise in practice. If it is found necessary to remove a plate, it may be done at the platen machine by using a small gas stove, and simply warming the particular plate to be changed. It may be replaced and again fixed by being applied to the adhesive mixture again, and run under the table three or four times in succession. The same expedient might be adopted at the cylinder machine, but perhaps it is not safe enough to deserve the trial, more especially as the complete bed may be removed with so much facility. The plates when worked off can be easily detached by a stout palette-knife used with a little dexterity. The bed with its coating of dry cement is then put on the steam-chest, melted, brushed over afresh, shunted on to the cold table, and left to harden ready for the next batch of plates.

With a most honourable feeling towards the craft of which he is so worthy a member, Mr. R. Clay, jun., the inventor of this new method of stereo-blocks, places his discovery at the disposal of his brother printers. As must be obvious to our readers, the materials required are very few and simple; they may be obtained, at slight cost, of Messrs. Wailes and Robinson, engineers, of 256, Euston-road, who have Mr. Clay's permission to supply the whole apparatus, which we recommend should be confided to the custody of one person, who would thereby acquire a great dexterity and speed in its manipulation. One workman would be equal to the requirements of twenty machines constantly engaged upon stereotype bookwork.—*Printing Times.*

A NEW SOURCE OF POWER.—ABSORBENT STRATA.

M. G. HANRIAN, of Meaux, France, has discovered a source of power in wells and absorbent rock strata, which is certainly both curious and original, and possibly capable of a wide utilization. He proposes to drive machinery or raise water through the absorption of water by the lower strata of the soil, the avidity with which the absorbent rock absorbs the water creating, in the descent of the latter, the power, which is transmitted by mechanism to the surface. This will be better

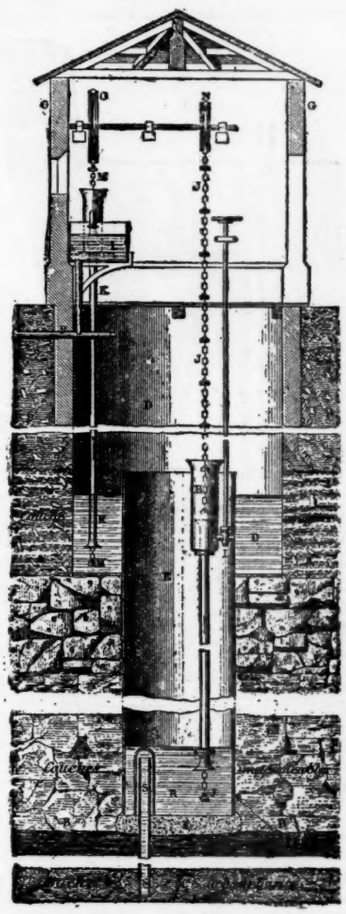


Fig. 1.

understood by reference to Fig. 1 of the annexed engravings, which we select from the "Bulletin du Société d'Encouragement pour l'Industrie Nationale." A well, D, is first dug until the water-bearing stratum is pierced. This well is suitably curbed, and then another and smaller excavation, E, is carried downward in the impermeable rock, B, until the absorbent stratum, C, is nearly reached. The bottom of this bore is covered with concrete, F; and a small tube, surmounted by a hood to prevent its being choked by impurities, is continued still further down and into the absorbent rock, C. Inside E is a sheet iron tube, H, entering a wide receptacle at its upper end (at the bottom of which sediment is deposited) and extending down into the water in the lower well. I is a valve governed by the hand wheel from above, which serves to admit water from the main well, D, into the tube, H. Said tube has within it one part of an endless bucket chain, J, which passes over and acts as a bolt on the pulley, N. Another tube, K, is placed in the well,

D, and this also contains a bucket chain, M, which passes over the pulley, O. The valve, I, being opened, the water in D, of which there is a continual supply from the springs in the aquiferous stratum, descends the tube, H, and enters the well, E; thence it escapes by the tube, S, through which it is forcibly drawn by the absorbent action of the rock at C. In its descent through I, the water, acting on the buckets of the chain, J, thus rotates the pulley, N. This pulley being on the same shaft as pulley, O, the latter also is rotated, and the bucket chain in pipe, K, therefore lifts the water from D, into the receptacle, M, whence it is led away for distribution by the conduit, P. The absorption which takes place through the layer, C, is said to be so complete that, when the valve, I, is closed, the bottom of the well, E (pipe, S, having perforated sides), becomes perfectly dry.

In Fig. 2 an entirely different arrangement of machinery is shown, the device known as Hero's fountain being utilized in-

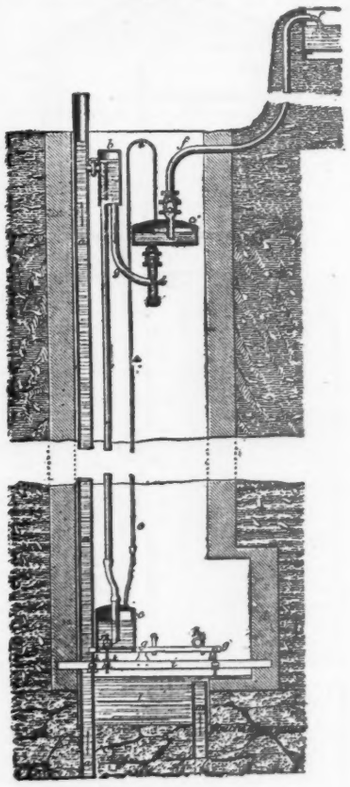


Fig. 2.

stead of the bucket chains. This is perhaps best applicable when the absorbent rock lies above the water-bearing stratum, as in the case of an artesian well. From the latter rises the tube, *a*, the water rising in which has access to the reservoir, *b*. A portion of the water descends into the lower receptacle, *c*, by the tube shown, compresses the air in said receptacle, and thus through the small pipe, *e*, causes a similar compression in the reservoir, *c*. But into the latter a portion of the water in *b* has likewise entered, through the conduits, *g* and *d*, and ball valves prevent its return. Consequently the water, in *c*, is compelled to ascend the tube, *f*, and thus is raised the required height, to a receiving reservoir above. As soon as the water which enters *c* is no longer equilibriated by the weight, *h*, on the lever, *g*, which holds shut the moveable bottom, said bottom falls open, and the weight, *h*, rolls to the left along the lever, holding the bottom in this position until all the water has escaped. Then the weight counterbalances, the bottom closes, and the operation above described is repeated. The water is at once absorbed by the surrounding rock; and this water, sinking in said rock, tends to displace the water in the layers beneath, and thus forces the same up the tube, *a*, keeping that conduit constantly filled.

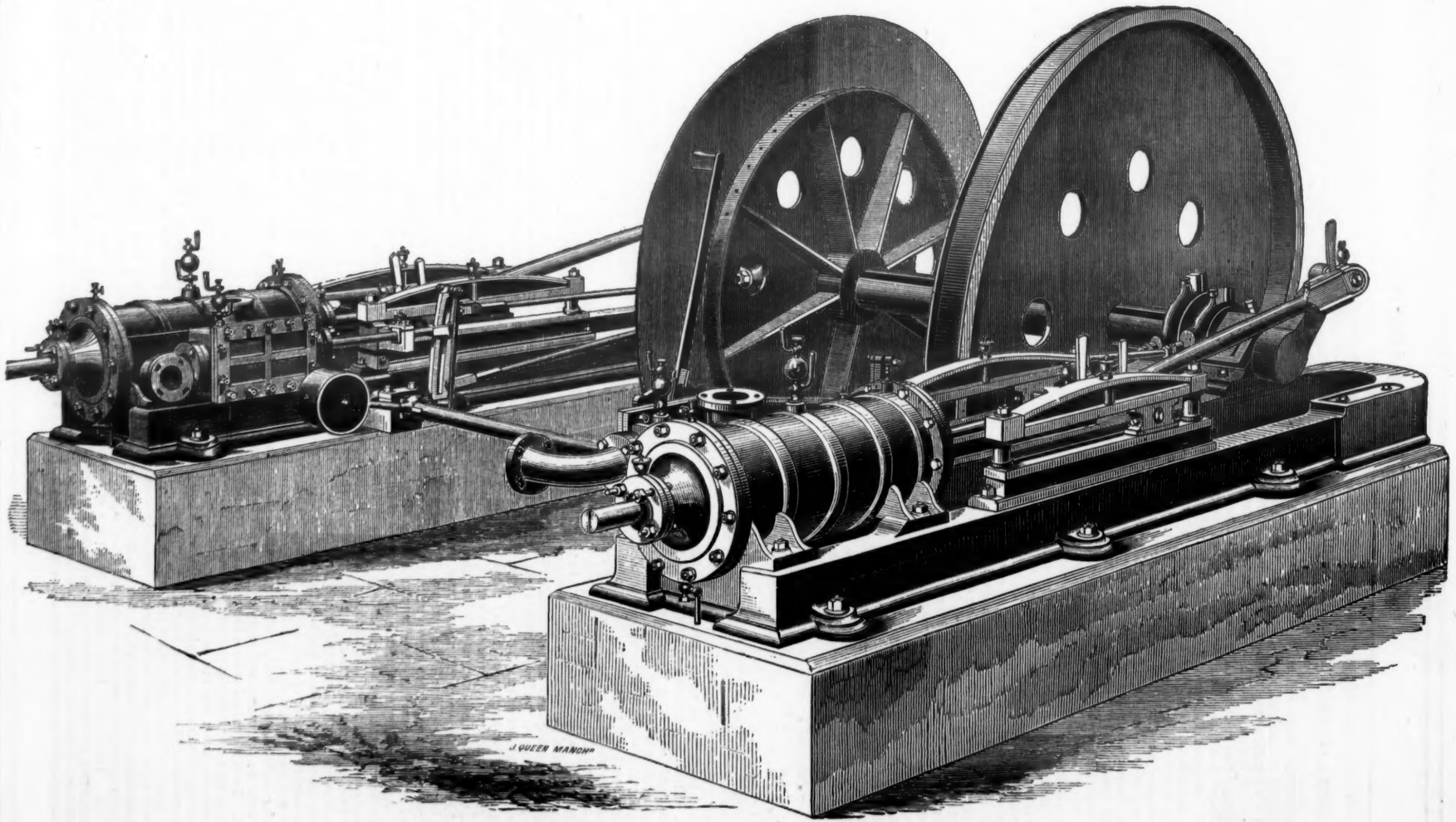
It is stated that at Bailly-Romainvilliers, near Couilly, in France, the arrangement first described, and shown in Fig. 1, is in operation, and lifts from 600 to 1,000 quarts of water per hour a distance of 22·4 ft., absorbing for this work from 2,500 to 4,000 quarts at a depth of 185·6 ft. The apparatus shown in Fig. 1 has raised 1,000 quarts per hour 12·8 ft., the sounding tube passing to a depth of 233 ft. These were little more than experimental trials, and therefore can hardly be taken as estimating the possible capabilities of the plan.

The advantage of course lies in a constant power, available wherever a water stratum and an absorbent stratum can be found. The principal obstacle lies in the choking of the pores of the absorbent rock by impurities, but this the inventor proposes to check by filtering the water, and by occasionally administering doses of hydrochloric or sulphuric acid, which will destroy organisms, &c., and expose a clear rock surface.

DOUBLE HORIZONTAL HIGH-PRESSURE WINDING ENGINE.

THE double horizontal high-pressure winding engine, herewith illustrated, is constructed by the engineering firm of Messrs. Pollock and McNab, of the Britannia Iron Works, Hyde, near Manchester.

These engines are mounted on strong and massive bed-plates, 9 in. deep, with a semicircular front; the bed plates are of the box girder system, with hand-holes cast in the inner frame to give free access to all the bolt-heads. The cylinders which are bolted on to these bed-plates are 16 in. diameter with a corresponding stroke of 3 ft., and the cylinder covers are turned and polished all over with extra deep stuffing-boxes; the cylinders show all the flanges bright, and have the valve chest or casing cast on; the covers of the latter are likewise neatly panelled, and have each joint faced all the way across. The coil-spring principle is introduced in the pistons, and thus a continuous elastic tension is imparted on the outer rings, keeping them perfectly steam-tight in the cylinders, without causing any undue friction, such as frequently arises when screws and wedges are substituted for this purpose. The piston rods, 3 in. in diameter, are of Bessemer steel, and extend through the back cylinder covers. The box-pattern is also adopted for the bottom slide bars, which rest with their entire under side on the fore-mentioned bed-plates, whilst they are flanged and recessed on the top sides for containing the lubricant, and also furnished with grit cavities at both ends. The upper sliding bars are very strong, and special attention has been paid in giving extra length and bearing surface to the sliding blocks. The connecting rods and crossheads are made from wrought-iron, and the crosshead ends of the connecting rods are made forked, with double bearings. The connecting rods are 3 in. in diameter, and swelled to 4 in. at the necks, whilst the crossheads are 3 in. in diameter in proportion to the other parts of the engine. The bearings of the latter are made with butts and straps, provided with gibs and cotters for tightening the brasses as they wear, and brass-mounted glass globe self-acting needle lubricators are fitted up for lubricating all the moving parts. The cranks are set at right angles to each other, and mounted on a best forged-iron turned drum-shaft, 9 in. in diameter, with 7 in. diameter necks. The crank pins are of Bessemer steel, and 3¾ in. in diameter. The drum-shaft is carried on pedestals or pillar blocks, constructed on the improved angle principle, which allows the solid part of the block to receive the thrust at each centre, and a sunk key-way is cut the whole length of the same crank-shaft, so that the position of and between the drum sides may be varied at pleasure and according to requirements. The valve spindles are also of Bessemer steel, 1¼ in. diameter, and are carried by a bracket between the ends of the slide bars, which thus form one of the pillars for the same. Working with double eccentrics and single slide valve, the reversing motion is on the curved slot link principle, and the stop valve is specially designed with a view to quick starting and stopping. Best hammered iron forgings are used for the links, which are finished bright and case-hardened; steel, however, is used for the pads for the links, and the pins connecting the eccentric rods. The cross shaft connecting the two link motions is carried under the floor line so as to be entirely out of the way of the attendant; whereas the reversing handle, stop-valve handle, foot-brakes, etc., are all brought within easy reach, and under the complete control of the engine-tenter. In conclusion, the drum sides are machine-made, and in halves, and a double-flanged seat for the brake-strap is cast on one of the drum-sides, and turned, to ensure a solid even surface for the brake-strap to bite against.



POLLOCK AND MACNAB'S DOUBLE HORIZONTAL HIGH-PRESSURE WINDING ENGINE.

BRUSSELS INTERNATIONAL EXHIBITION, 1876.

THE daily and weekly journals have already described the general features of this divisional collection, and also reported the amenities and honours which characterized its inauguration. The selection of Brussels for such a purpose is an evidence of tact which the events have entirely justified. Belgium is not merely a neutral ground whereon many of the gravest problems of race, creed, and political economy are tested by experience; that neutrality of position is accompanied by a sympathy for excellence, a desire after improvement, and an independence of spirit. This independence of spirit has, however, these facts to commend it—the country is not warlike: it seeks by freedom to vindicate its equality among nations and governments that have unbounded resources, and by its conduct under trying circumstances, and its enterprise under peaceful ones, it has acquired the dignity it sought, and has thoroughly fulfilled the hopes upon which the kingdom was created.

This journal is compelled to limit its notice of the gathering, which until October will be open at Brussels to matters of a practical character having to do with the constructive arts; the mass of literary matter treating of institutions and means for improving the condition of the working classes is not within its province, although of great value to all in every land who desire to better the condition of those labourers who by reason of the roughness of their occupations are not qualified to learn many of the truths which especially affect their class.

We think the contributions sent from England bearing on the apparatus for diminishing the dangers attending those whose life is on the water, and to prevent accidents or give aid when they occur, to be a very important and useful feature.

The Lords of the Admiralty exhibit sections of the cellular system of constructing ships to prevent their sinking when pierced or damaged by collision or by running on banks, and also sections of plans for ventilating ships in various ways. To these are added working models of self-acting ventilators for expelling foul and supplying fresh air without draught, for pumping out impure air from between decks. In models are the fireproof ventilators for spirit-rooms, to prevent the passage of flames by creating winding passages, &c., and for stopping shot-holes and leakages in ships in three different cases of great danger. There is Coryton's anchor, one of very singular construction, and combining advantages that enable it to bite readily, to hold all the more that it is strained, to keep clear of injuring the ship when ridden over, to be taken to pieces and stowed on board and then quickly put together when wanted, to be adapted in any emergency to larger ships than originally intended, and capable of easy repair. Then follow models of screw-moorings with capstan-head for turning it into the ground; a model of the sliding caisson for the new dock at Malta, Remington's graving dock for Bermuda (1859), fireproof store houses at Devonport Dockyard, built in 1814, the Royal Navy single wrought-iron capstan and cable-holder, Blake's fire-hearth cooking gallery for ships, adopted by the English navy; bag-racks; cabin fittings with all the equipments, drawers, cot, book-shelves, table, and washstand, as fitted to all ships in the navy.

Ships in distress use a patent record buoy, in case their situation is hopeless, in which all the letters and papers and documents are placed, and is so contrived that the sun's rays are reflected at a long distance. Another useful aid is a temporary rudder, made of a hempen cable cased by wood, one of which sufficed the Warren packet for sixty-three days; spare rudders, boat-lowering hooks, and finally lifeboat models. The parent lifeboat—that of Shields, presented by the Duke of Northumberland—was the invention of Mr. H. Greathead, in 1789, and used up to 1820 at South Shields. The boat had this terrible defect, she could not free herself of water or right herself if upset. This also is true of Fincham's 1851 boat, but in 1851 Commodore Lord John Hay made one resembling a whaleboat, with air-case, that would right itself if upset, and carry off the water it happened to ship. To this is added several life-rafts and a seamen's bath for use in seas where sharks abound: it is merely composed of eight screw-plates let into the deck close to a scupper, whereby the discharge hose can be inserted to run the water overboard; the canvas bath, &c. is made on board.

The Board of Trade contribute the models used in the examination of masters and mates for certificates in seamanship and navigation, the knowledge of the international code of signals, the rule of the road at sea, and the use of all life-saving apparatus. These latter have complete apparatus and means of transporting rockets &c., uncharged; directions for landing wrecked crews; plans of rocket machines, cart and house. The rocket apparatus has superseded that of the mortar, but both are the invention of Captain Manby, although the idea had occurred to and been experimented on by others. The carrying and using the line by the aid of rockets, after many attempts, was practically established by Mr. Dennett, of Newport, Isle of Wight, in saving life, and it was adopted in 120 stations up to 1853. Other changes followed, and finally, in 1857, the Board of Trade took up the matter, and it may be of interest to describe the apparatus and the method of working. A rocket is fired, which carries a line over a ship; the crew haul on the rocket-line, and this brings an endless rope, called a whip, rove through a block, with a tail attached to it, which is made fast to a mast or some other portion of the wreck high above the water. Those on shore then haul off to the ship a hawser attached to the whip, which is made fast to the mast, or other portion of the wreck, about eighteen inches above the whip. Those on shore then set the hawser up by means of a triangle and an anchor, haul it taut, and send off to the ship the sling life-buoy secured to the whip, and travelling along the hawser, to which it is suspended by a travelling-block. When the buoy reaches the ship, one of the shipwrecked persons gets into it, and it is hauled back. The process is repeated till as many are saved as can be. Sometimes only six minutes are lost between the firing of a rocket and the landing of the first man.

The Corporation of Trinity House lend permanent floating lighthouse apparatus, and also models of lighthouses. One of these is that at Wolf Rock, near Land's End, seventeen feet above low water, and only two at high tide. It is exposed to all the fury of the Atlantic. The place had been marked by an iron beacon, which, after being frequently broken down by the sea, was displaced by this erection after nine years' labour. The flashes of red and white light alternate every half minute, and the apparatus is of the first order. The whole cost amounted to £62,726. There is also a model of St. Catherine's lighthouse, Isle of Wight, a land lighthouse station, with accommodation for three families. It marks the southern extremity of the island, and assists the Channel navigation.

The Royal Humane Society furnish models of boats and apparatus adopted by them. There are folding ice ladders, which are easily pushed over the ice, and a length of ladder falls from the end into the water, to enable the immersed persons to climb up to the surface in safety; and there are also hand-ladders, pole drags, rope drags, cork life-buoys, life-belts, &c., of the newest construction. The unsinkable boat is also sent: it is for duty at bathing places, with a view to safety in surf or broken water, is sixteen feet long, and will support twelve persons.

The Royal National Life Boat Institution have forwarded their well-known full size life boat and transporting carriage, as used all round our coasts. This boat is thirty-three feet in length, and rows ten oars. It possesses every improvement that science and experience have suggested, being difficult to upset, of great speed, easy of launching and landing, discharges its own shipment of water, rights itself if upset, is very strong, and can take in a great number of passengers. The Institution also exhibits the improved fishing boat—a larger one than is usually employed, and divided into compartments, the middle one being provided with hatches and water-tight cover for heavy weather, rendering it incapable of being sunk by breaking waves. Their life-buoy, belts, &c., are shown, as also the drag used to check a boat's progress and to keep its stern towards the sea when running for land, which is a very important matter in many parts of the coast. Life boat houses and transporting carriages, instructions of all kinds to persons engaged or exposed—these complete the useful contributions of that Society.

But the articles supplied by manufacturers must not be unnoticed. For instance, ship filters, by Bischof; life-saving jacket and the waterproof garments, &c., of Davis and Henwood; a life-saving trunk against accidents at sea, by W. R. Gade, 82, Addison Road, Kensington—a patent oblong box, which by the act of opening makes a life-boat, and is said to be a useful invention, and even if the suddenness of danger prevented preparation, it would save the wrecked from being swallowed up by the sinking vessel. The life-boats and models sent in by H. T. Richardson, of Wales, the diving apparatus of the North British Rubber Company of Edinburgh, the pumping machines of Messrs. Gwynne of Hammersmith, Messrs. Forrest, coast and ship's life-boats sent from the Limehouse Works, and launching, lighting, and steering contrivances, form a most instructive collection, which cannot be inspected without gratitude that so much has been done to lessen the "dangers of the seas."

The saving of life from fire, and the protection of property, form a very important class in this exhibition. In the matter of lightning conductors, Messrs. Newell & Co., of 130, Strand, offer a first-class selection; their copper rope lightning conductor has been well known all over the world for the last twenty-five years and is held to be the most perfect conductor of electricity known.

They exhibit a new patent point for conductors—Newell's Infusible Point is likely to supersede all other points, being a better conductor and much cheaper than the platinum points usually adopted.

Then in the construction of fire-proof floors and roofs, girders and joists, Homan and Rodgers of Gracechurch Street, exhibit specimens of the system known as Belgian joists or pontrelles, introduced by Mr. Homan some ten or twelve years ago, that consists of the combination of iron and concrete cement. Portland cement concrete offers to a compressive strain or load a resistance nearly equal to that of stone, and is therefore suited for the upper surface of joist construction; but it would readily break, and therefore the under surface by this method is composed of iron with a tensional strength of twenty tons per inch. By this combination floors and roofs will withstand any ordinary test. The works are easily executed, will resist fire and water, and are much less costly than any other. The plan had the opposition of architects and engineers, but it has become established not only here but throughout the world, and is extensively used for riveted girders at a saving of twenty per cent. Sanderson and Procter, of Huddersfield, exhibit an automatic fire extinguisher and alarm, of which they are the inventors. It is applicable to all buildings where steam is used, being attached by opening a valve in the boiler, which, connecting with a valve in the room on fire, fills it with steam and extinguishes the fire. We are in no position to judge of its success; it seems likely to be of much service. The proprietors give away their particulars at the exhibition, and indeed that may be said of many others.

There is no necessity for particularizing the apparatus of the Royal Society for the Protection of Life from Fire, the life-saving dresses and similar apparatus, even to Mr. Irvine's stall of helmets, epaulettes, axes, belts, and life-lines—these are familiar to all who reside in large towns. Nor is it our province to remark on the aids to agriculture, and the many educational items for children, and for the bettering of the social condition of the people. A final notice, on the habitations and on some sanitary matters connected with construction, may appear in our next.

W. S. C.

THE PRACTICAL NOTE-BOOK OF TECHNICAL INFORMATION USEFUL TO STUDENTS AND WORKMEN.

(105.)

ELEMENTS of Cabinet Making.—In note No. 99, pp. 169-172, vol. V., we gave in fig. 575 part of one of the ornamental sides of a "what-not," and in fig. 576 the other part of the same "what-not;" we now give in fig. 624 the central part (the centre line being indicated by the letters A B) of the back ornamental part, and in fig. 625 the remaining portion to the right, the two together forming one-half of the whole back part.

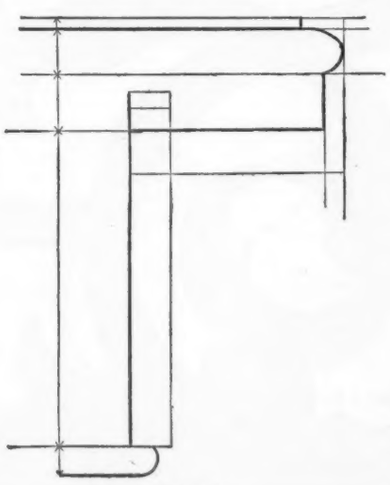


Fig. 626.

In fig. 626 we give a section of part of the outside of the top of a "dining-table," in fig. 627 elevation of same, in fig. 628 elevation of one of the legs of ditto. In fig. 629 to 633 various details of the "chairs" to suit the table. In fig. 629 we give part elevation, showing the leg and part of top, in fig. 630 section of "side rail" of the chair, in fig. 631 part elevation of ditto, in fig. 632 part elevation of "back rail" of the chair, with section towards the right hand; in fig. 633 part elevation at end of "middle rail" of the chair, with section towards the right hand.

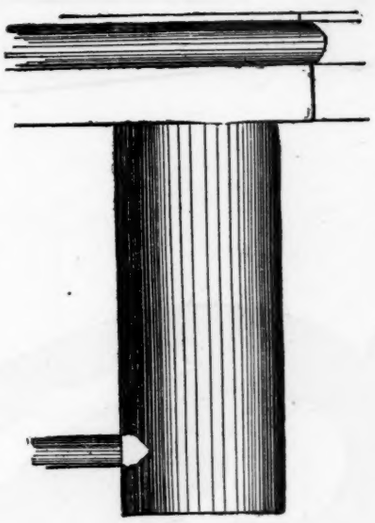


Fig. 627.

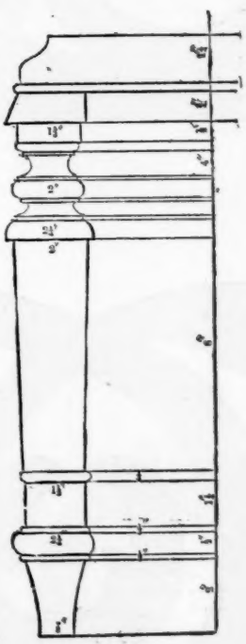


Fig. 628.

(106.) The various forms of Arches used in Architecture, and some of the methods in use to describe them.—*Semi-circular and segmental Arches.* In fig.

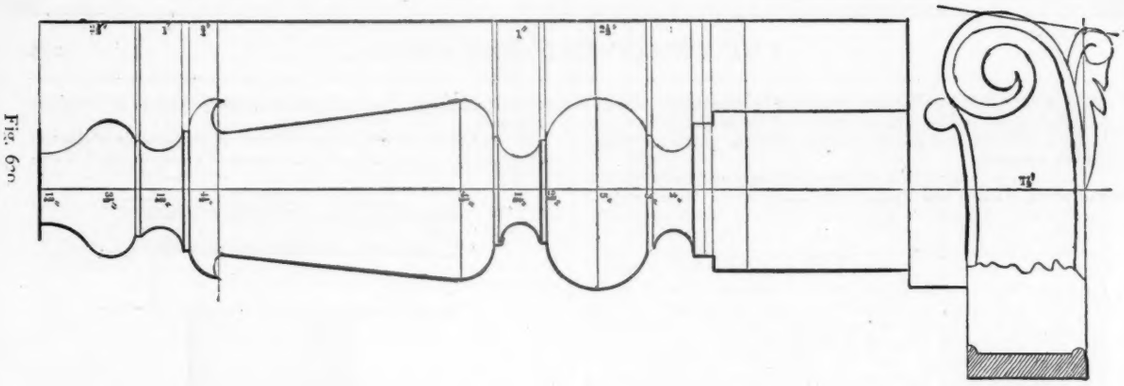


Fig. 633.

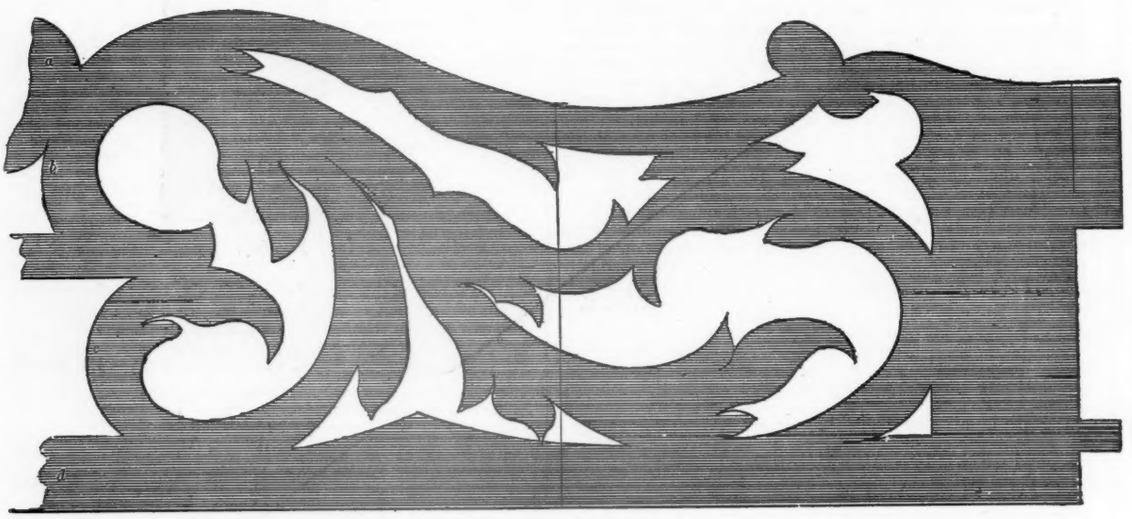


Fig. 625.

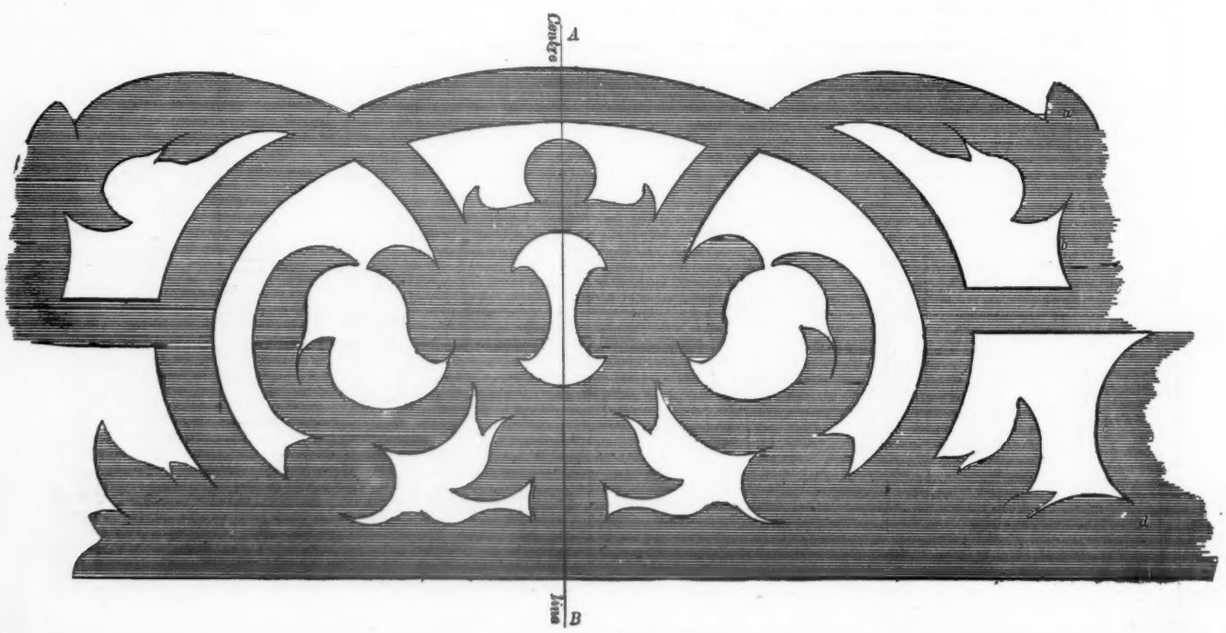


Fig. 624.

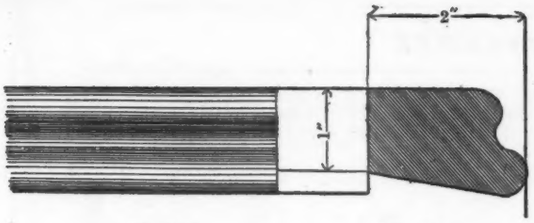


Fig. 631.

Fig. 630.

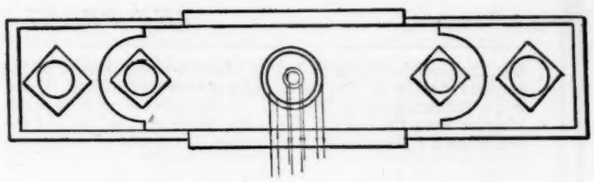


Fig. 644.

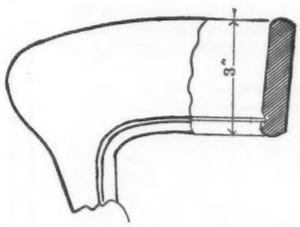


Fig. 632.

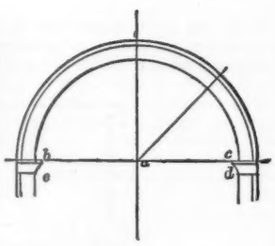


Fig. 634.

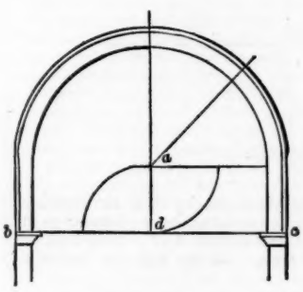


Fig. 635.

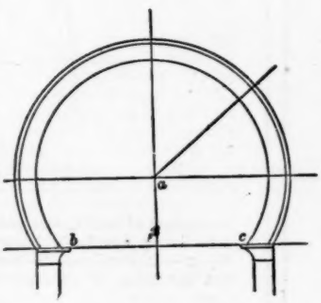


Fig. 637.

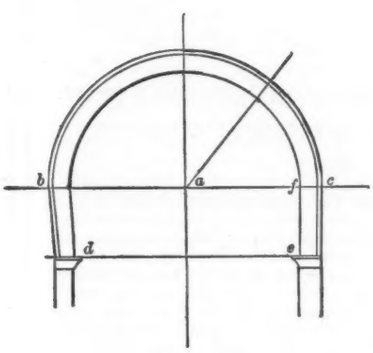


Fig. 636.

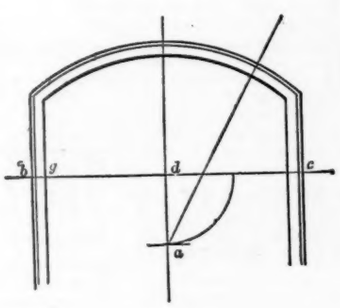


Fig. 638.

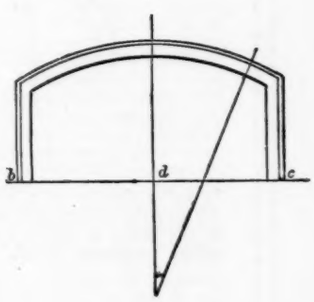


Fig. 639.

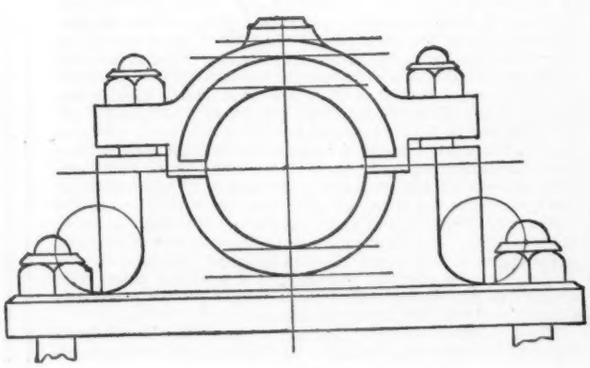


Fig. 645.

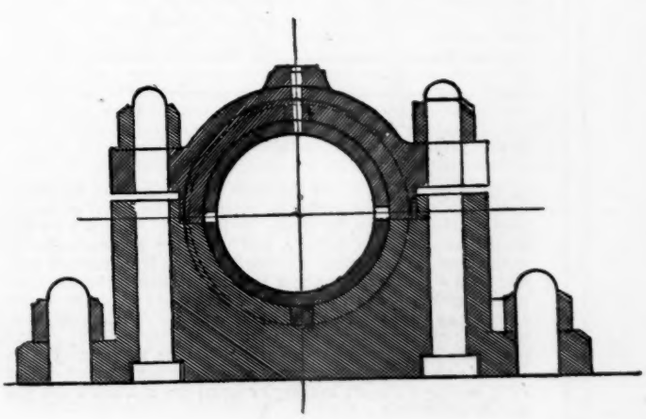


Fig. 643.

634, the semicircular arch has its centre *a* in the line *b c* of the imposts *d e*. In fig. 635 the centre *a* is above the line of impost *b c*, a distance equal to half *b d*. In fig. 636 the arch is semicircular from the line *c b*, the centre being at *a*, as in fig. 635; but below *c b* the sides incline in towards the line of impost *d e*

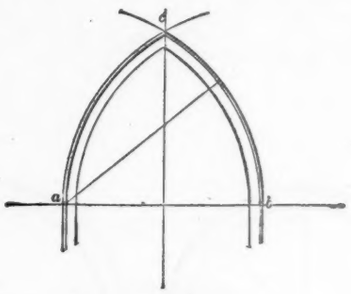


Fig. 640.

—the rate of inclination being about one-fourth of the distance *c f*. In fig. 637 the arch described from centre *a*—formed as in fig. 2—is continued to meet the impost *b c*. This arch is the *horseshoe* or *Mooresque* arch. In fig. 638 the centre *a*

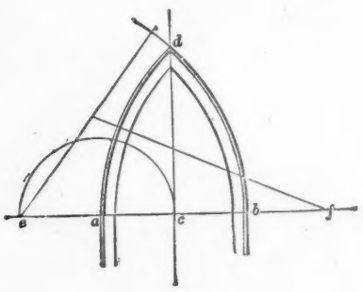


Fig. 641.

is below the line *b c*, equal to half the distance *c d*. In fig. 639 the centre *a* is still further below the line *b c*, equal in distance *c d*, half of *b c*. Fig. 638 and 639 are what are called "*segmental arches.*" In fig. 640 is the *equilateral arch*

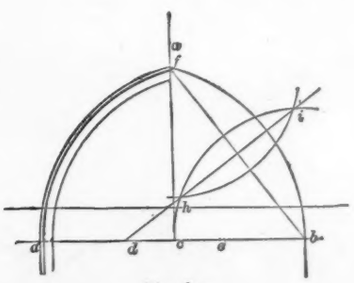


Fig. 642.

or *ogive arch*. Let *a b* be the span, and from these points as centres describe arcs cutting in point *c*. The *lancet* or acute-angled triangle arch, is shown in fig. 641. Let *a b* be the width, bisect this in point *c*, and draw the perpendicular or centre line *c d*. Produce *a b* indefinitely on both sides of *c d*; and from *a* with *a e*, describe a semicircle *c e*, or make *a e* equal to *a c*; make *c f* equal to *c e*, and from *e* and *f* as centres, with *e b a f a* as radius describe the arcs *a d*, *b d*. The *drop arch*, or obtuse-angled triangle arch is in fig. 642 described by joining the points *b f*, *a f*, and bisecting them by arcs intersecting as at *h* and *i*; and through the points of intersection drawing a line *i h d*, cutting *a b* in *d*; making *c e* equal to *c d*, *d* and *e* are the centres of the arcs *a f*, *b f*.

(107.) **The Student's Note Book of Working Drawings.**—Resuming the subjects, under this heading, which have been for various reasons kept back for a time, we give in

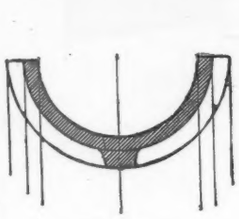


Fig. 646.

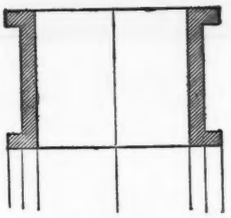


Fig. 647.

fig. 643 the front or side elevation, fig. 644, the plane, fig. 645, the vertical section of a "plummet block" or "pedestal" for a horizontal shaft; in fig. 646 the cross section, in fig. 647 the

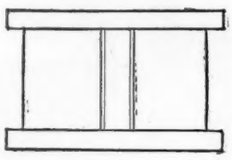


Fig. 648.

plane or horizontal section, and in fig. 648 the plane of another side of the "bran" or "bush."

A FEW PRACTICAL HINTS ON FREE-HAND DRAWING AS APPLIED TO INDUSTRIAL DESIGN.

No. I.

HAVING since the commencement of this journal devoted several articles to the subject of mechanical drawing and projection as applicable to numerous problems of great utility to the student, and to the delineation of forms, which, although coming under the head of ornamental subjects, have been drawn mechanically, it has been suggested to us that a practical purpose would be served and much benefit might accrue to a not inconsiderable body of our younger readers or less advanced students by our devoting a few articles, more or less brief, to the subject coming under our title as above given. Of the utility of such a series there can be no doubt; of our ability to do justice to it within the brief limits which can be assigned to it in the pages of a journal which occupies itself of necessity with the consideration of so many subjects, for which at all times there is the minimum of space with the maximum of interest, time alone can show. Of the utility, as we have said above, of such a series there can be no doubt; a mere glance at the pages of any one number of this magazine will dispel such doubt, should it exist in the minds of any of our readers. The addition of the latter part of the title of our series will do the same; for the words of this indicate how it lies at the root, so to say, of all drawings in connection with the industrial arts in which design is concerned, and wide as this is in its scope and work, the utility of our subject is wider still, for it is difficult to name any of the branches of industrial callings in which an ability, and what is more, a facility—the student should here-note the distinction made, for it is important, as we shall hereafter see—to transfer to paper or to canvas, or other material, the outcome of the taste, the genius, or the skill of those who follow them, in which form or design is embodied. Even to those engaged in the purely mechanical departments of industry, a facility to sketch forms is often of great practical service. Taking then its utility as granted, and it would be exceedingly difficult to deny it, we shall without further preface proceed to the practical work of our proposed series.

The difference between "mechanical" and "free-hand" drawing may be very briefly stated. In mechanical or "construc-

tive drawing," as it is sometimes called, the various forms required to be delineated are put down with great precision by the aid of certain mechanical appliances or instruments. Straight lines are drawn in by means of the T square, the straight edge, or the set squares, while circles or parts of circles are described by means of the "compasses," of which there are several kinds, according to the nature of the work each kind has to perform. Many of the forms or "figures," as they are generally termed, are described by rules, forming what are called "problems," which are invariable and are never altered, although there may be more than one method or problem of describing the same form or "figure." All measurements are also taken by means of the instruments with the most scrupulous accuracy, and transferred as scrupulously to the paper; nothing is left to chance; all is done, must be done, with "unvarying precision and accuracy." Everything put down on the paper is drawn in with a mechanical precision and accuracy, by means of appliances more or less numerous and more or less costly, and by means, to a great extent, of rules or problems modified according to the wants of the draughtsman.

In "free-hand" drawing all this mechanical precision is dispensed with, or if displayed, as it often is, in many forms and designs, it is done wholly without the use of any mechanical applications or helps; or if these are used they are few in number and of the simplest character, the eye and the hand being the guide and means by which all lines, however varying in form and character, are or should be drawn in.

In free-hand drawing proper, curved lines as well as straight, straight (or right) lines as well as curved, are in no wise aided by mechanical appliances. And as with the drawing in of these, the straight or curved lines, so with the distances by which these are separated, and the forms or shapes which they assume; no help is derived from any instrument, the eye alone must be the guide to estimate the distance, the hand the means by which the lines and forms so estimated are put down.

The student, therefore, will see the vast difference between the two classes of drawing; and in the latter or "free-hand" the importance first of that cultivation of the "eye" which will be able to estimate respectively distances of lines from one another, and of the form which these lines assume; and second, the importance of being able with a certainty of touch to transfer to the paper, &c., by the "hand" these distances and forms so estimated. The two are thus found to go together; the eye taking in with accuracy what is to be done, the hand helping the eye by transferring it with ready ease to the medium by which the work of both is made manifest to all onlookers, and by which it is preserved.

While the appliances or instruments of the mechanical draughtsman are comparatively expensive—a full set of the best construction being indeed very costly—those of the free-hand draughtsman are by no means so, those required for the beginner being attainable for the outlay of a few pence only. A small drawing board, which will cost from 1*s.* 6*d.* to 2*s.* 6*d.*; a few sheets of common cartridge paper, costing for the first lessons tenpence or a shilling a quire; a pencil marked HB, if a "dozen" packet be bought at a time, it will cost what Jeremy Diddler would have called the "miserable sum of tenpence"—bought singly a penny a piece (a better quality which it will be as well for the beginner to use, will cost twopence each); a penny cake of indiarubber, and half a dozen "drawing pins," costing twopence or threepence, will "set the young draughtsman up in tools" which will meet his requirements for a goodly while. The paper may be fastened to the drawing board by means of the "drawing pins," one at each corner; but a piece of gummed paper will do; or if the student be of a very economical turn of mind, the gummed margins of postage stamps will serve his turn admirably. When the student becomes more advanced in his lessons, and more ambitious in his attempts, the paper must be of a superior quality, and fastened to the drawing board by the "damping" process, all of which will be explained in due time, but for the early lessons simplicity will characterize all the proceedings. There is one thing, however, which the student will not find so simple as it appears to be on first naming it, that is, "pointing his pencil." Not a little patience has been expended in this process, and not a few pence either, for breakage after breakage, in the too often vain attempt to put a fine point on the pencil, soon makes the pencil disappear in a heap of "whittlings." In the first place, the knife to be used in pointing must be a good penknife (we forgot to include this in the list of appliances), what is called an "artist's knife" is the best, and the blade must be sharp. The first operation is to expose the lead by cutting off the wood, beginning at a point about three-quarters of an inch from the end (the end of the pencil upon which the mark indicating its quality or degree of hardness, as B, BB, HB, H, HH, or HHH, being that of course which is not used first). The lead is exposed by cutting the wood off in a conical form, which cutting must be done gently—not whittled at, as we have seen some do, as if it were a garden-rope pin they were fashioning—the pencil being allowed to rest upon the thumb or fore-finger. It is when the lead is exposed and the attempts begun to put the point to it that the patience and the lead alike are so frequently both broken and lost. The method we have adopted is one we have rarely found to fail us in giving a point of any degree of fineness we may require, and which, as rarely breaking the pencil, is as efficacious as it is simple. We discard the knife altogether as soon as the lead is exposed and the wood taken off to the degree required, and then we rub the lead *gently*—using scarcely any pressure, for even a slight pressure, with the leverage obtained by the length of the lead unsupported by the wood, will very easily break the lead—on the surface of a piece of *fine sand-paper*, the same as that used by cabinet makers, &c., to smooth the surface of their wood work. Since we began to use this simple appliance—a penny sheet will last a couple of years, so that it is as cheap as it is simple—we have saved many a pencil and a good deal of temper. To all draughtsmen who have not already done so we say "Try it." Some refine on this simple plan, and have a piece of steel cut file-fashion as part of their appliances. All things being now ready, the paper fastened on the board, the pencil pointed, the young student is ready to begin his first lesson.

Materials have been recommended for beginners other than the cartridge paper and pencil, such as the common slate and slate pencil, and also charcoal crayons in place of pencils, and very coarse paper. In favour of the "slate plan" it is stated, first, that it is "very cheap" (to which we may reply that practically there is little difference between the cheapness of this and of the pencil and paper plan); secondly, that all errors can be quickly erased and new attempts made. One writer on the subject states that this is a great recommendation, inasmuch as it will be a very long time indeed before the student can do anything worth keeping. We are not quite so sure, however, that this is any advantage; on the contrary, we think that a practical good is to be derived from the student retaining his sketches from the very beginning: by examining them from time to time he will be able to trace the faults he has committed, and thus be able to correct them, and, apart from this, there is in after days a pleasure of a certain kind to be derived from looking over his early "essays." Moreover, as even in the most evil things there is a trace of good, so may he from his bad beginnings be able to get a hint now and then for the doing of things better. We know that this is the case in mechanical drawings, for in the sketches of "schemes and new inventions" which from time to time vex the brains of beginners, there are often in after times some suggestions picked out of real value. But the great objection to the slate and slate-pencil plan which we have is a practical one after all. They are not the materials by which, as he arrives at an advanced stage of his progress as a free-hand draughtsman, he will continue that progress,—which, in point of fact, he will use at all. He will be obliged to discard them, and therefore we maintain that it is practically useless to begin with materials which he cannot continue to use. Still further, there is another objection: the difference between working with slate pencil and slate as the drawing surface, and working with ordinary pencil on ordinary drawing paper, is so great that the transition or change from the use of the slate to that of the paper will not be so easy, will in fact be difficult; and difficulties enough the pupil will have in any case without multiplying them unnecessarily.

The same objections, although in a much more modified degree, will be found to attach to the charcoal crayon and rough drawing paper proposed by other authorities. These materials are said to give to the pupil-student "a light and free touch," or rather, to compel him to give this in drawing in his lines. We greatly doubt whether these attributes are to be gained by the use of any material or materials merely. These attributes of the "masters of the art" are not to be got out of charcoal and rough paper, any more than they are to be got out of the use of pencil and paper of the ordinary kinds. Something higher far gives them, but nothing else. Hard work, thorough struggling to master difficulties, and above all the genius which gives the true touch of art to all it does, are the means by which lightness and freedom of touch are attained. Others again, as Ruskin for example, recommend the use of pen and ink for the first essays of the art-student, with any odd scraps of paper which come first to hand, as the materials on which these are to be set down; and certainly one advantage will be obtained by the use of these—the capability of the "yielding pen" to make lines of all degrees of fineness, to express nearly all shades of delicacy,—something which few comparatively have thought of. The efforts, however, of the student are stereotyped, so to say, at once, and kept recorded for after examination, while the very fact that no "indiarubber work,"

no erasure, can be permitted, or is indeed possible, throws the student back upon his powers to do his best, and shames him, as it were, out of all carelessness, in which he is too apt to do his worst. There is, in fact, a great deal to be said in favour of the "pen and ink" materials, much more than in favour of the slate and the charcoal crayon. There is still another method which has been recommended for the beginning of art-students, namely, "the black board and the white chalk," with regard to which we will only observe that much of what we have said of the slate and the charcoal system applies to this. Upon the whole, looking at all the points, we are inclined to recommend the ordinary pencil and drawing paper—in fact, the appliances we first named—as the best for the young student to adopt. They are the most readily obtained, and are those which he will in nine cases out of ten, in his after practice, daily use.

Not a few beginners of the art will perhaps have a difficulty to believe that all drawings, no matter how complicated, are composed or made up of but two classes of lines; first, the straight line, and second the curved line. Let the beginner in free-hand drawing examine any number of designs, and from the simplest to the most complex of these he will find clearly marked the truth we have stated, that they are made up of the above two classes of lines, the straight and the curved. And his first work, and he will find it real work, demanding his most earnest attention and care, will be to master the difficulties attendant upon the drawing correctly of a "simple straight line" and of a "curved line." About these, and much more than these, we shall have somewhat to say in future articles or lessons.

THE SPONTANEOUS COMBUSTION OF COAL IN SHIPS.

THE Royal Commissioners appointed "to make inquiry with regard to the causes of the spontaneous combustion of coal in ships, and the remedies which it may be possible to adopt for preventing and guarding against the same," have presented their report. It appears that in April, 1874, the Board of Trade decided to hold no more inquiries, under the Merchant Shipping Act, into casualties caused by explosions or fire in coal-laden vessels, for the reason that the finding of their courts, which invariably took the form of an exoneration of the ship's officers, and a recommendation in favour of better ventilation, seemed to be entirely disregarded, both by shipowning and underwriting interests. Later in the year, the Committee of Lloyd's urged the subject anew on the attention of the Board of Trade, and adverted to the serious increase in the risk to life which appeared to be involved in respect to coal-laden ships. A list of the casualties for the preceding sixteen months showed an extraordinary number of disasters from spontaneous combustion on board such vessels. But the Board of Trade still demurred to a renewal of their inquiries, on the ground that no few facts were ever elicited, and that the conclusions at which the courts had for years invariably arrived, had apparently been productive of no practical results. Holding these views, the Board of Trade suggested that some serious steps should be taken by those who own, manage, and insure these ships and cargoes, to profit by the facts already proved, and to secure the safety of their vessels by better ventilation, by the provision of means for extinguishing fire, and by caution in the description and condition of coal shipped. To this there was a reply from the Salvage Association, pointing out the desirability of referring the question to a commission consisting of men of tried scientific attainments, and especially acquainted with the nature of coal in all its conditions, and of men acquainted practically with coal, both at the pit and in the ship's hold. This proposal was referred by the Board of Trade in January, 1875, to the Committee of Lloyd's, who expressed their hearty concurrence, and, in the end, the Royal Commission was appointed which has now reported. At the head of this commission was Mr. Childers.

It is a singular fact that the recommendations of the Board of Trade appear to have been much more generally adopted than was imagined, and to this very adoption may be attributed some portion of the increase in the number of casualties. During the last few years cases of spontaneous combustion have greatly increased in number, and during that period there had been a much more general adoption of ventilation in the holds of coal-laden ships. Under pressure from other quarters, owners and masters of vessels have adopted ventilation against their own inclination and judgment, with results which tell unmistakably against the practice.

It must be observed that there are two kinds of ventilation in regard to a coal-laden ship. One is through the body of the coal, and the other is from the surface. These two methods differ widely in their effects. Surface ventilation carries off the light inflammable gas which would otherwise lead to an explosion; but ventilation by means of shafts through the body of the coal increases the risk of spontaneous combustion. The distinction between combustion and explosion is important. The former may be spontaneous, but the latter requires the presence of a light in order to ignite the explosive gas.

In addition to the peril created by the mistaken advice of the Board of Trade, coal has of late years been more generally of a dangerous quality than formerly. This has been due to two causes—namely, the inferior character of the coal supplied from the pits, and the breakage to which it is subjected by the more rapid modes of loading the vessels. Mr. Cooper Rundell, accountant to the Liverpool Underwriters' Association, who had collected for his employers a variety of statistics relating to spontaneous combustion in coal ships, was of opinion that want of care in the selection of coal had a good deal to do with the increase of casualties in 1873 and 1874. Mr. Rundell stated in his evidence, "There has been a great demand for coal, and a ready sale has been found for inferior and unclean sorts, which would not formerly have been marketable. I have been told this, that formerly men were fined for sending up bad coal, but that they are not fined for doing so now. The coal agent, in order to meet the demand, appears to accept anything passed to him." The same witness also asserted that the Mines Regulation Act, which came into force in 1873, and restricted the labour of children, had the effect of rendering a great many boys no longer available who were formerly employed in cleaning and selecting the coal. The shipment of small coal has also undergone considerable development, and helped to increase the risk. The danger which is created by the breakage of coal in loading, attracted much attention from the commissioners. Modes of loading are specified in which the fall of that portion of the coal which is first put on board, especially in large and, therefore, deep ships, is very considerable; and the consequent accumulation of small and crushed coal under the hatchway has, it is believed, in many cases promoted spontaneous combustion. In addition to the crushing of the coal when falling the full depth into the vessel's hold, there is a further process which tends in the same direction. That is to say, as each load falls on the central heap, the large coal runs down the sides and is trimmed away to the ends, while the smallest coal, fine slack and dust, clings to the heap where it falls, or gradually accumulates in a compressed mass under the hatchway, and experience shows it is at this spot that spontaneous combustion generally originates. The evil of this accumulation of small coal was insisted on by many witnesses. In South Wales it is said to be the practice to dig out a quantity of small coal from the hatchway, after the vessel has completed her loading, and to replace it by larger coal, thus showing the existence of a feeling that danger may arise from an extended surface of small coal.

The fallacy with respect to through ventilation is strikingly illustrated in the case of four vessels, the "Euxine," "Oliver Cromwell," "Calcutta," and "Corah." These ships were loaded under the tips at Newcastle, at the same time, with the same coal, and from the same seam, sometimes one ship being under the tip and and sometimes another. Each carried from 1,500 to 2,000 tons of coal. The first three were bound for Aden, and the "Corah" for Bombay. The former were all thoroughly ventilated, but the "Corah" was not ventilated at all. The last-named vessel carried her cargo safely to Bombay, but all the others were totally lost from spontaneous combustion. Of the seventy vessels that suffered in 1874 none are reported as not having been ventilated, while thirty-eight are distinctly stated to have been ventilated, thirty-five of them being vessels of over 500 tons.

Concerning explosions, the commissioners state that the risk varies very materially according to the character of the coal, and that there is more peril to human life from these catastrophes than from spontaneous combustion, as they occur too suddenly to admit of provision being made for personal safety. On the other hand, it is much easier to provide against explosion than combustion. With regard to the means to be employed for extinguishing fire, the commissioners believe that water and steam are the only agents practically available for the purpose of extinguishing fire in cargoes of coal.

The Royal Commissioners summarise their conclusions as follows:—

1. That certain descriptions of coal are intrinsically dangerous for shipment on long voyages. 2. That the breakage of coal in its transport from the pit to the ship's hold, the shipment of pyritic coal in a wet condition, and "especially ventilation

through the body of coal cargoes" conduce to spontaneous combustion, even though the coal may not be unfit for conveyance on long voyages. 3. That spontaneous combustion in coal cargoes would be less frequent if regard were had by shipowners and underwriters to these facts. 4. That when coal is being carried on long voyages, the temperature in the various portions of the cargo should be tested periodically by thermometer, and registered in the log. 5. That, with a view to guard against explosion, free and continued egress to the open air, independently of the hatchways, should be provided for the explosive gases, by means of a system of "surface" ventilation, which would be effective in all circumstances of weather. 6. That in order to make known the descriptions of coal liable to combustion, the inspectors of mines should be instructed to hold inquiry into all cases of spontaneous combustion occurring in cargoes of coal taken from their respective districts; exporters being required always to record on their specifications the denomination of the coals forming the cargo. 7. That no additional legislation with reference to the conveyance of coal by sea is required, unless for the purpose of giving effect to the proposals thus made with regard to the inquiries by inspectors of mines, and to the fuller specification of coal entered outward at Her Majesty's Customs.

The inquiry conducted by the commissioners was materially assisted by a scientific paper drawn up by two of their number, Professor Abel and Dr. Percy. It is therein stated that pyrites appear to be the only sulphur combinations occurring in coal which, by their oxidation, promoted by the presence of moisture and by mechanical conditions favourable to the accumulation of the heat developed by such oxidation, are liable to give rise to what is called the spontaneous ignition of coal. Carbon, in a finely divided or porous condition, has the property of absorbing and condensing within its pores large volumes of certain gases, among which is oxygen. The condensation of gas by a porous body is attended by the development of heat proportionate to the extent of that condensation. A good illustration of this action is furnished by the very porous charcoal prepared for the manufacture of gunpowder. This has to be protected against rapid access of air for some considerable time after it has been removed from the carbonizing retorts, otherwise the charcoal, though it may have been allowed to cool down perfectly, will become heated, upon exposure to air, to such an extent as to ignite spontaneously. Ignition is not uncommon during the grinding of the charcoal, owing to the large extent of surface thus brought into contact with the air. The spontaneous ignition of oiled cotton or silk waste is due to the same law. The porous fabric serves as a vehicle for exposing the readily oxidizable oil or grease, in a finely divided condition, to the air, and thus favouring a rapid oxidation. These facts have a direct bearing on the spontaneous ignition of coal. The finer the particles of the latter the greater is the facility for absorbing oxygen and thereby developing heat. After a careful investigation of this part of the subject, Professor Abel and Dr. Percy say it does not appear practicable to apply ventilation with any prospect of guarding against the accumulation of heat in some portion of a cargo of coal. The renewed supply of oxygen furnished by the introduction of a fresh volume of air, would obviously favour the process of absorption, "so that a period would be reached sooner or later when the development of heat would be most seriously promoted by ventilation, some time before actual ignition demanded the total exclusion of fresh air." The conclusion is therefore warranted, both on scientific grounds and from the evidence of facts, "that it is inadvisable to attempt through ventilation of cargoes in coal-laden ships." It is only to be regretted that through the lack of sound scientific advice the Board of Trade should have exercised its influence in the wrong direction, so as to aggravate the evil it sought to cure.

RAISING THE "VANGUARD."

SOME curiosity was excited early in the spring of this year by an announcement on the part of the Admiralty that they were prepared to receive tenders for the recovery of the "Vanguard," which was sunk last autumn off the coast of Ireland. In spite of rumours to the effect that a contract had been entered into, it is now known that nothing has been yet done, and that, so far as the Admiralty is concerned, no effort will be made to raise this vessel. Whether the terms of the contract were too stringent—and they certainly had a forbidding rather than an attractive look—or whether no satisfactory tender was ever made, it is impossible to say, as the action and views of the Admiralty on the matter have not been made public, and still remain a mystery. But it is certain now that any effort of the kind is to be abandoned, as the vessel is publicly offered for sale. What this means is, we presume, simply that if any one, simple or sagacious, wishes to become possessor of a fine ironclad, he has only to make his offer and pay his money, and he can then become the proud owner of the most unique property in the British Isles. The Admiralty possibly believe that the vessel can be raised, and think this the safest mode of realizing their hopes; at all events the offer can hardly be made unless evidence of some kind has been produced that the "Vanguard" can be raised. Whether, however, the Admiralty are convinced or not of the possibility of recovering this vessel, it is unquestionably certain that success is neither impossible nor impracticable. Although raising sunken vessels is not a matter which has attracted much public notice, it is a branch of naval science to which a considerable amount of attention and ingenuity have of late years been devoted. In Russia experiments on a large scale have been from time to time conducted, and the "Popoff" air-bag, which had been proved successful in a number of instances, was regarded favourably in this country and used by the Admiralty. The use of compressed air, of which this invention is an instance, is becoming every year more fully recognized in engineering efforts of various kinds, but its application to the raising of sunken vessels, though urged in many quarters, especially since the loss of the "Vanguard," has not been very general. Mr. H. F. Knapp, a civil engineer, has been constant and confident in his efforts to popularize the use of compressed air in this direction, alleging as one of its most important advantages the disuse of cumbrous machinery and the certainty that the application of air, when successful, leads to the immediate recovery of the vessel and its easy removal into harbour. Years ago, it may be noticed, this system in a modified form was applied, but only to small vessels and in circumstances which gave no value to the results. A more important attempt was, however, made to raise a man-of-war belonging to the United States about thirty years since, but the bags were unable to stand the strain of the air, and burst before they could be applied. Mr. Knapp gives an account of another attempt made in 1852 by an American inventor; a large amount of money was provided, an apparatus constructed carefully and skilfully was supplied, and air-bags of from fifteen to twenty-five tons capacity were used, with novel appliances for relieving any undue pressure of the air; but in spite of these precautions, several of the bags burst as the vessel rose to the surface, and the unfortunate inventor had to endure the aggravation of seeing the vessel he had been at such pains to raise, quietly but rapidly return to her submarine resting-place. In fact, up to a very recent date, two almost insuperable difficulties presented themselves—the bags and the cost. To make bags light enough not to counteract the use of the air, and at the same time strong enough to endure the varying pressure of the air they contained, was unattainable except at a large cost; unless the bags were absolutely air-tight, they proved useless, and unless the recovery of a vessel could be effected at a small cost the attempt would be also useless, as few sunken vessels would be worth a large outlay. The "Popoff" air-bag, which has proved remarkably successful under various trials, gets over the first difficulty only to encounter the second; for a 60-ton bag costs £250, but even then, india-rubber, which is used in the manufacture of these bags, is easily injured. When to this liability to fracture is added the difficulty of attaching the bags, it can readily be understood that any attempt to raise an ironclad like the "Vanguard," with her large initial weight enormously increased by the pressure of the water under which she lies, may be regarded, pardonably, as impracticable.

To remove these difficulties several remedies and inventions have been attempted, of which it will be sufficient to notice two. Mr. Knapp proposes to revert to the old process of using chains underneath a wreck of the size of the "Vanguard," but in a way to remove the objections which he himself raises, and which are inseparable from the old rough and ready ways of using them. Then, to obtain lifting power, he proposes to apply an apparatus which shall be gradual in its application, and capable of being used in rough or fine weather. For this purpose he proposes to use pontoons with an open bottom, but otherwise air-tight. These pontoons are to be used in sufficient numbers near the vessel, and sunk beside it. Nothing remains, then, but to attach them skilfully to the vessel and pump air into them till the vessel rises. This plan has the merit of simplicity, and overcomes the difficulty of using bags; and the pontoons have the advantage of being cheaper and more durable than the bags. Another plan has been suggested by Mr. Reece in a lecture given at the United Service Institution. He proposes to go further than Mr. Knapp by dispensing with air-pumps and pipes and supplying a floating power very much greater than atmospheric air. His plan involves the use of hydrogen gas, which, being fourteen times lighter than air, he assumes will have therefore a correspondingly

greater buoyancy than air, and be therefore more sparingly used. This hydrogen gas is to make itself in iron vessels clamped to the ship's side; and, when enough gas has been made and enough buoyancy produced, up, of course, will come the hydrogen tanks and the vessel with them. These are only two of many suggestions and ingenious inventions which the loss of the "Vanguard" has produced. Of their practicability and value it would be premature to give a definite opinion. But one difficulty we have yet to notice. How are these chains, and bags, and pontoons, and tanks to be attached to such a vessel as the "Vanguard"? To do this divers must be employed in large numbers, and the employment of divers at a depth of twenty fathoms, with facilities to enable them to crawl about the ship and arrange everything securely and correctly, is no easy matter. It is said that divers have already inspected the "Vanguard," and that she lies twenty fathoms under water. But the ordinary dress of a diver does not allow of the most experienced man working in more than fifteen fathoms of water; and if this is the case an insuperable difficulty arises. It would appear, however, that this is surmounted by a new dress which has recently been invented, but which is not in use in the Navy.

Here, then, it would seem that the most serious difficulties have been surmounted; and if such is the case, there is no reason why the "Vanguard" should not be raised. Apart from the importance of recovering such a valuable vessel, it is, perhaps, not realized what a new and formidable danger sunken ironclads would present in time of war. Unless such a vessel can be raised she will, simply, if sunk at the mouth of a harbour, remain an insuperable obstruction to navigation. The old method of blowing-up vessels sunk in time of war is useless with ironclads, because gunpowder or nitro-glycerine would only have the effect of forcing out the decks, while their hulks would hardly be affected. In calling attention, therefore, to this subject we are not merely paying a tribute to engineering skill, which may be nteresting, if unprofitable, but calling attention to a danger which demands recognition, and requires that every effort to remove it should be encouraged.

SULZER'S DETENT STEAM-ENGINE.

THE reputation of SULZER'S Detent is already established. Numerous statements from German workshops attest the superior action of engines constructed at Augsburg on SULZER'S system. These engines of 500 horse-power have one or two cylinders, and are with or without condensation. Experiments, very carefully made by M. Linde, Professor at the Munich Polytechnic school, on a 100 horse-power engine at Munich, show that the consumption of water per horse per hour is 8·92 kilogrammes (19¾ lbs.), for a normal force of 106 horses, and the consumption of fuel is one kilogramme (2·2 lbs.).

We give a view of this engine, with two diagrams of the indicator. The advantages of these engines may be summed up as follows: very small consumption of fuel, quiet and regular action, careful construction and facility of access to all the parts. The normal force in working with condensation is obtained with a steam-pressure of five atmospheres in the cylinder, the detent commencing at one-eighth or one-tenth of the course, but it may work very easily with less by half.

The cylinder is horizontal, and connected in a straight line with the crank shaft by a solid frame. The guide of the head of the piston is pierced and drilled on the same axis as the cylinder, so that the axes of these two parts are exactly in the prolongation of each other.

The steam distribution is effected by means of four valves nearly balanced, set in motion by a shaft under the control of the governor. Those valves open and shut instantaneously, act without noise, keep always steam-tight, and are easy to remove, because the whole of the distribution mechanism is outside the cylinder. The space capable of doing injury is reduced to a mininum, and the condensation water which is deposited in the cylinder can continually flow through the lower valve. The governor is self-acting on the distribution, and its action is perfect.

The cylinder and lids are supplied with steam envelopes, into which the steam passes before entering the cylinder. Moreover, a special lining and a wooden casing prevent the cooling of the cylinder. The envelope and the cylinder are cast in one piece, and composed of compact hard metal of superior quality. The piston rod is of cast steel, and in engines of more than 30 horse-power it is prolonged behind the cylinder and supported by a guide.

The crank-shaft, crank-pin, and chief parts of the steam-distribution are of cast steel, the crank, the rod, and the cross-head of the piston are of extra forged iron, the bearings and chests are of bronze. To avoid wear as much as possible, all the moving surfaces are very much developed, and arranged in such a way as to be capable of being easily adjusted.

The fly-wheel is turned. In small engines it may have a transmission strap or a cord. In more powerful engines the fly-wheel is either arranged to take a strap, or furnished with iron teeth cut by machine. The pinion has wooden teeth.

The air-pump has india-rubber valves set in motion by the crank shaft with the aid of an eccentric, and it may be placed slant-wise, as in the figure, or horizontally under the cylinder. *Moniteur Industriel Belge, June* 10, 1876.

Chemistry applied to the Arts, Manufactures, &c.

ABSTRACTS FROM FOREIGN PERIODICALS, TRANSACTIONS OF SOCIETIES, ETC.

BLACK Diamonds.—Of all diamonds, the most valuable in price and hardness is the black, which is generally met with in pieces of the size of a pea, and sometimes in lumps of more than a thousand carats. It is opaque, and its external appearance is much like that of iron ore, with metallic reflections sometimes. Its texture is of a uniform grey tint, like that of steel. Its hardness is such that it can serve for working transparent diamond, and is much greater than that of steel.

An American diamond-cutter has by persevering exertions succeeded in working black diamonds, and using them for piercing stones, steel, and other metals. *El Porvenir de la Industria, July* 28, 1876.

Marine Soap.—For washing with sea-water, M. MANIN manufactures a soap from the following materials :—

Animal or vegetable oils or fats, 40 per cent.		
Resin	10	„
Glue of any kind . . .	40	„
Oxalate of potass . . .	1	„
Soda or potass	9	„

M. Manin states that the soap has the appearance and condition of ordinary soap, and clothes are whiter and softer to the touch in spite of being washed in salt water. *El Porvenir de la Industria, June* 2, 1876.

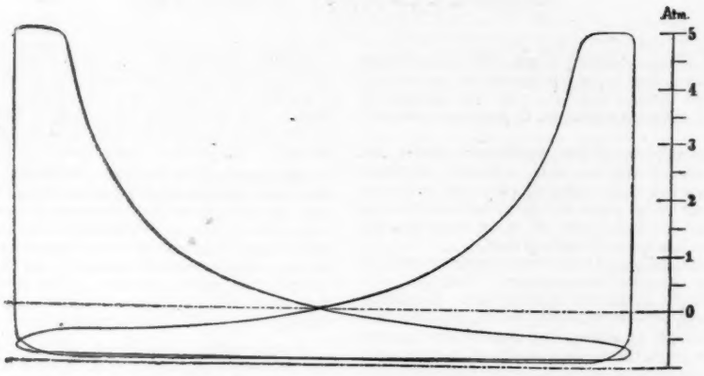
Gas Escapes.—It is usual to employ flame as a means of discovering where gas escapes. Sometimes this has been attended with serious consequences, which may be avoided by the following method :—A solution is prepared of 2 lbs. of dark soap in five to seven pints of hot water. The sticky liquid so obtained is applied with a brush wherever gas-escapes are suspected, and the bubbles that are formed show the positions of the escapes without any danger. *El Porvenir de la Industria, June* 17, 1876.

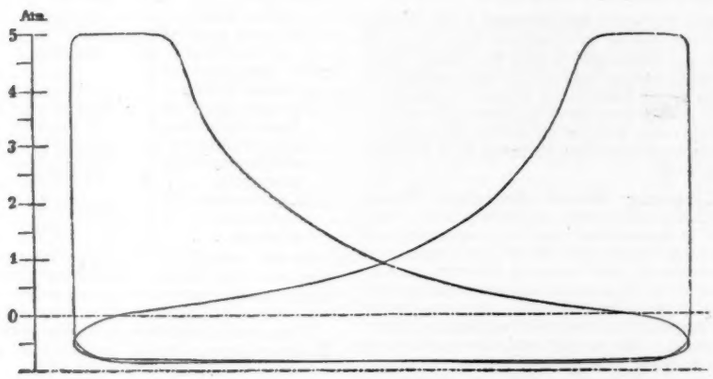
Mastic for Retorts.—A mastic for application to gas retorts, which has been for some years employed with advantage in various workshops, is obtained from the following materials :—

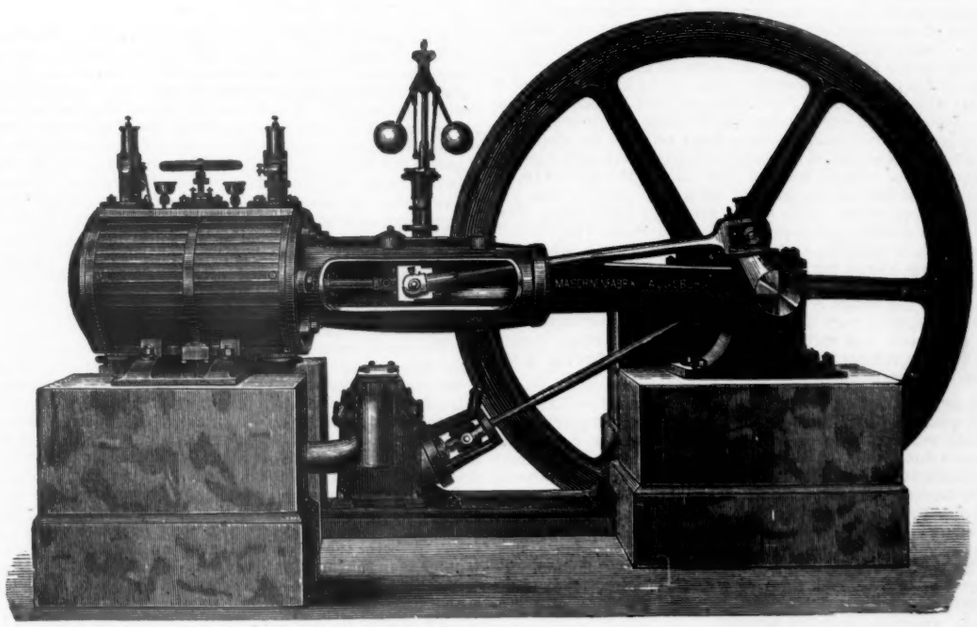
10	parts	of potatoes.
30	„	of flowers of sulphur, or sublimed sulphur.
1	„	of glass.
1	„	of fine sand.
1	„	sal ammoniac.
1	„	horse-dung.

El Porvenir de la Industria, July 7, 1876.

To Remove Nitrate of Silver Stains, without the use of cyanide of potassium : Chloride of copper is first applied to the tissue; it is next washed with hyposulphite of soda solution, and afterwards with water. It is said that this may be employed on coloured woven cotton tissues. For white cottons and linens, dilute solutions of permanganate of potash and hydrochloric acid, followed by the hyposulphite of soda and clear water, is preferable. For cleaning the hands, we use iodine dissolved either in iodide of potassium or in alcohol, followed by aqua ammonia. *Grimm, in the Polytechnisches Notizblatt.*







SULZER'S DETENT STEAM-ENGINE.

Purification of Illuminating Gas.—In order that all the sulphate of iron employed in the purification of gas may be transformed into oxide without any loss, and the mixture obtained may be effectual and economical, M. G. JOUANNE proceeds thus :—

He mixes 220 lbs. of sulphate of iron, powdered coarsely, and 55 lbs. of quick lime slaked with the water necessary to obtain a dry powder, well together with a shovel, turns on to them a current of steam, or sprinkles them lightly with water while he turns over the mixture with the shovel till it begins to dry and assume the characteristic colour of oxide of iron.

He leaves the mixture, collected and conveniently covered, till the very moment for charging the purifiers. Then for each 220 lbs. of mixture he adds 22 gallons of coke-dust. He prefers this material to sawdust, because it is found on the premises, and merely requires the labour of sifting, and purifies the mixture more effectually, since, with the same quantity of material, the oxide with the coke-dust lasts 25 per cent. longer than with sawdust. The revivification of the mixture is also easier, more complete, and quicker.

A small addition of lime from time to time favours the activity of the material, in case some small quantities of oxide may have been transformed to sulphate of ammonia by the oxygen of the air. *El Porvenir de la Industria, June* 2, 1876.

Improvements in Cutting Millstones.—The French Society for the Encouragement of National Industry have awarded to M. G. Roger, millwright, a prize for having found out a method of preparing the surfaces of millstones by means of a machine in a separate enclosed space, without requiring the presence of workmen, and consequently without injury to their health. The Council have also awarded prizes for two improved forms of the wet masks used to protect workmen from the dust. *Les Mondes, July* 13, 1876.

Process for Cleaning Silver Articles, Plate, Jewellery, &c.—Chalk, rotten-stone, and bone-powder, which are usually employed in households, have the inconvenience of requiring great labour, and scratching the articles cleaned. A convenient and expeditious mode of cleaning perfectly, consists in well rubbing the objects with a piece of linen impregnated with pure and concentrated liquid ammonia. It is necessary for the cleaner to stand in a current of air, and avoid wetting the fingers with the liquid ammonia. The articles are afterwards to be rubbed with a dry linen cloth. The method has been tried with success by M. J. J. LEROY, of Brussels. *Industrie Progressive.*

Bismuth is found in considerable quantities in Utah. In Bingham Canyon traces have been found in a number of mines, while in the Socrates mine, situated on Sheridan Hill, some fine specimens of sulphide of bismuth, or "bismuth glance," have been found that assayed as high as 32 per cent. pure metal. This, however, was an extraordinary occurrence, and further investigation proved the deposit to be of very limited extent. A number of deposits of small area occur in this territory, some of them of surprising richness, but the evident insignificance in quantity makes the working of the deposits out of the question. One notable exception, however, exists in the bismuth mines of Beaver County, called the Starr King and San Francisco mines. This deposit gives every indication of being a permanent vein, and has had considerable money spent on it in development. The two mines adjoin on the same vein, which has been exposed to the depth of several hundred feet. From the surface to the bottom of the shaft a broad belt of ore is seen, varying from 3 to 8 feet, or even wider. This ore is extremely hard, being filled with coarse garnets, and impregnated with arsenic. The bismuth is evidently a sulphide, and is found in the ore in a proportion varying from 3 to 12 per cent.

This deposit, so far as we know, is the largest and richest in the world; the mines in Saxony, from which is procured the principal quantity annually consumed, yielding never more than ¾ or 1 per cent., and that only in connection with other metals. The market price for bismuth is now about $1·85 per lb. *Utah Weekly Miner*, i. 32.

Characteristics of Eosine upon Stuffs.—To distinguish eosine from saffranin and other colouring matters the most striking reaction is its inverse transformation by debromisation into fluorescein. Under the influence of sodium amalgum fluorescein is very readily recognized by its splendid uranium-green fluorescence of an extreme sensibility. But this reaction, indicated by M. Baeyer, requires a skilful hand. The following procedure is easy and certain. Collodion is coloured by all the dyes derived from aniline, by Magdala red and alizarin; eosine, on the contrary, is immediately decolourized by collodion. To detect it upon a tissue a drop of collodion is sufficient; if the tissue is dyed with eosine or methyl-eosine a white spot is produced. *Deutsche Industrie Zeitung.*

Black Varnish.—A black varnish, composed as follows, is found useful for gas meters and other metal articles :—

44 lbs. of pitch or tar, and 11 lbs. of india-rubber or gum elastic are boiled till the whole is reduced to about 33 lbs. When it is required for use, it is diluted with water, and well stirred. *El Porvenir de la Industria, July* 7, 1876.

Inoxydizable Britannia Metal.—M. MARLIE gives the following formula for the production of a Britannia metal which does not tarnish :—Iron, 10 parts; nickel, 35; yellow copper, 25; tin, 20; and zinc, 10. The substances being fused and mixed, the mixture is heated to white heat, and cooled in a mixture containing 60 parts of sulphuric acid, 10 of nitric acid, 5 of hydrochloric acid, and 25 of water. The alloy should remain in the acid only a very short time, otherwise it is evident it would be rapidly dissolved. *Art Dentaire.*

Antiseptic Qualities of Benzoic Acid.—Trimble has published the results of a series of experiments upon benzoic acid, in which the antiseptic properties of the substance named are compared with those of salicylic acid.

The results of the author are shown in condensed form in the following table :—

	One part of Salicylic Acid.	One part of Benzoic Acid.
To 2,000 parts of Infus. Buchu .	Spoiled in 8 days.	Remained unaltered after 60 days.
To 4,000 parts of Infus. Buchu .	Spoiled in 4 days.	Spoiled in 16 days.
To 8,000 parts of Infus. Buchu .	. . . .	Spoiled in 5 days.
To 2,000 parts of Infus. Colombo.	Spoiled in 16 days.	Cloudy, but no change of colour in 16 days.
To 1,000 parts Sol. of Albumen (1 in 16 water) . . .	Spoiled in 19 days.	Unaltered after 30 days.
To 4,000 parts Sol. of Albumen (1 in 16 water) . . .	Spoiled in 10 days.	Spoiled in 19 days.

In the case of the infusions above referred to, it should be remarked that without the addition of an antiseptic they would have commenced to decompose within twenty-four hours, and the solution of albumen within forty-eight hours.

The author's further experiments relate to the trial of the antifermentative qualities of benzoic acid, which were found to be not inferior to those of salicylic acid.

His main conclusions are :—

1. Benzoic acid, sublimed or artificial, possesses valuable antiseptic qualities.
2. It has the power to arrest decomposition.
3. As an antiseptic it is superior, in many, if not in all cases, to salicylic acid. It has also the advantages of being obtained in a state of purity and of having a lower commercial value. *American Journal of Pharmacy*, iv.: vi. 347.

Silicate of Soda in Textile Industry.—*Application in Wool Scouring.*—Silicate of soda is now used in many places with the best success in washing and scouring wool. It must be remembered that for scouring the wool the temperature of the water and silicate of soda may be higher than in the treatment with soap and soda. For scouring the wool in the leviathan, only silicate of soda is added to the first bath instead of soda, and to the second bath only half the usual amount of soap and soda. It is advisable to squeeze the scouring liquors out thoroughly before washing the wool cold in the machine, as this liquor can be kept twice as long as soda or soap liquor, if it is only kept warm. The wool scoured with silicate of soda always appears more white, open, and soft; the latter is the case, however, only if the wool has been thoroughly squeezed before the cold washing. Wool treated in this way is, without question, cleaner, takes the dye more rapidly and better, and turns out whiter after sulphuring.

The same experience holds good of woollen yarn, from which the grease is to be removed. It is sufficient to move them simply backward and forward in very hot silicate of soda solution, to turn the skein on the stick, then to move them up and down on the stick in the hot solution, to squeeze, rinse, or ring in cold water in order to obtain in this simple manner not only a beautiful, but unfelted, clean white skein; nay, the yarn is much cleaner than if treated with soap, soda, ammonia, &c. (If the yarn is impregnated also with Irish moss, a little soda.) On making a comparative test, for example, by introducing a skein scoured with silicate of soda, and another cleansed with soda, at the same time, into an aniline bath, the former will take up the colour brighter and purer than the latter, in a quarter of the time; if they are now exposed to the sun, it will appear that the colour of the former is also faster than the other.

As silicate of soda has no felting properties it cannot be used

in fulling cloth. Still it would be difficult to find a better means of cleaning the cloths before fulling than by sprinkling a warm solution of silicate of soda over them while they are running over the rollers in the washing machine. But the cloths must not be washed cold before the grease has been entirely removed in the washing machine; on the contrary, they should first run through some pure warm water, which is poured into the machine for the purpose. The dirty liquor is run off while the goods are being sprinkled with warm water, and they are then rinsed with cold water. This whole manipulation requires scarcely half an hour, as the grease and dirt are at once dissolved by the silicate of soda. Fugitive colours are attacked even less by silicate of soda than by soap; cochineal only, being an animal colour, would disappear entirely.

(Dr. Grothe next discusses the cleansing of cotton waste from machinery, &c., by means of silicate of soda, for which purpose it is said to be excellent.)

Application in Bleaching.—In bleaching, silicate of soda has a great future before it; according to experiments which I have personally made in large scouring and bleaching establishments, I can positively assert that silicate of soda will displace the use of soda in bleaching. Even goods that hitherto could not be bleached without detriment to the fibre, *e.g.* jute, become dazzling white in a very short time by the following process:—Jute goods (yarn) are laid from fifteen to twenty minutes in a solution of silicate of soda at a temperature of 158 to 172° F. (6 to 8 lbs. silicate of soda being taken to 100 lbs. of water), and turned several times with a stick; they are next rinsed in hot, but not boiling water, followed by cold water, entered, as usual in bleaching, into a weak "bleach," and, lastly, into a "sour," and the conviction will be gained that jute can be used not only as the finest white material for paper, but also for the finest white fabrics.

Hemp and cotton yarn, instead of being boiled six or eight hours in strong soda solution, are only moved up and down for from ten to fifteen minutes in a very hot solution of silicate. For 100 lbs. of linen yarn, about 12 to 15 lbs. of silicate of soda are used, which still costs 30 per cent. less than the usual 10 lbs. of 90 per cent. soda ash. After the silicate of soda bath the yarn must be agitated once more in hot pure water, and then rinsed cold, after which it is poured into a "bleach" and "sour" as usual. All baths, with the exception of the cold bath before the "bleach," which must be running constantly, can be used at least three times. *Dr. H. Grothe, in the Polytechnisches Zeitung.*

THE PRESIDENT OF THE BRITISH ASSOCIATION ON PRACTICAL SCIENCE.

[The following portions of the address of Professor Thomas Andrews at the opening of the 1876 meeting at Glasgow of the British Association are reproduced here, for the reason that they bear so directly upon the objects and work which the conductors of the PRACTICAL MAGAZINE have always had before them.]

IT is often difficult to draw a distinct line of separation between the physical and chemical sciences; and it is, perhaps, doubtful whether the division is not really an artificial one. The chemist cannot, indeed, make any large advance without having to deal with physical principles; and it is to Boyle, Dalton, Gay-Lussac, and Graham that we owe the discovery of the mechanical laws which govern the properties of gases and vapours. Some of these laws have of late been made the subject of searching inquiry, which has fully confirmed their accuracy, when the body under examination approaches to what has not inaptly been designated the ideal gaseous state. But when gases are examined under varied conditions of pressure and temperature, it is found that these laws are only particular cases of more general laws, and that the laws of the gaseous state, as it exists in nature, although they may be enunciated in a precise and definite form, are very different from the simple expressions which apply to the ideal condition. The new laws become in their turn inapplicable when, from the gaseous state proper, we pass to those intermediate conditions which, it has been shown, link with unbroken continuity the gaseous and liquid states. As we approach the liquid state, or even when we reach it, the problem becomes more complicated; but its solution, even in these cases, will, it may confidently be expected, yield to the powerful means of investigation we now possess.

Among the more important researches made of late in physical chemistry, I may mention those of F. Weber on the specific heat of carbon and the allied elements, of Berthelot on thermochemistry, of Bunsen on spectrum analysis, of Wülner on the band-and-line spectra of the gases, and of Guthrie on the cryohydrates.

In the application of science to the useful purposes of life chemistry and mechanics have run an honourable race. It was in the valley of the Clyde that the chief industry of this country received, within the memory of many here present, an extraordinary impulse from the application by Neilson of the hot blast to the smelting of iron. The Bessemer steel process and the regenerative furnace of Siemens are later applications of high scientific principles to the same industry. But there is ample work yet to be done. The fuel consumed in the manufacture of iron, as, indeed, in every furnace where coal is used, is greatly in excess of what theory indicates; and the clouds of smoke which darken the atmosphere of our manufacturing towns and even of whole districts of country, are a clear indication of the waste, but only of a small portion of the waste, arising from imperfect combustion. The depressing effect of this atmosphere upon the working population can scarcely be overrated. Their pale, I had almost said etiolated, faces are a sure indication of the absence of the vivifying influence of the solar rays, so essential to the maintenance of vigorous health. The chemist can furnish a simple test of this state of the atmosphere in the absence of ozone, the active form of oxygen, from the air of our large towns. At some future day the efforts of science to isolate, by a cheap and available process, the oxygen of the air for industrial purposes may be rewarded with success. The effect of such a discovery would be to reduce the consumption of fuel to a fractional part of its present amount, and although the carbonic acid would remain, the smoke and carbonic oxide would disappear. But an abundant supply of pure oxygen is not now within our reach; and in the meantime may I venture to suggest that in many localities the waste products of the furnace might be carried off to a distance from the busy human hive by a few horizontal flues of large dimensions, terminating in lofty chimneys on a hillside or distant plain? A system of this kind has long been employed at the mercurial mines of Idria, and in other smelting works where noxious vapours are disengaged. With a little care in the arrangements the smoke would be wholly deposited, as flue dust or soot, in the horizontal galleries, and would be available for the use of the agriculturist.

The application of artificial cold to practical purposes is rapidly extending; and, with the improvement of the ice machine, the influence of this agent upon our supply of animal food from distant countries will undoubtedly be immense. The ice machine is already employed in paraffin works and in large breweries; and the curing or salting of meat is now largely conducted in vast chambers, maintained throughout the summer at a constant temperature by a thick covering of ice.

The decline of science in England formed the theme, fifty years ago, of an elaborate essay by Babbage; but the brilliant discoveries of Faraday soon after wiped-off the reproach. I will not venture to say that the alarm which has lately arisen, here and elsewhere, on the same subject will prove to be equally groundless. The duration of every great outburst of human activity, whether in art, in literature, or in science, has always been short, and experimental science has made gigantic advances during the last three centuries. The evidence of any great failure is not, however, very manifest, at least in the physical sciences. The journal of Poggendorff, which has long been a faithful record of the progress of physical research throughout the world, shows no signs of flagging; and the Jubelband by which Germany celebrated the fiftieth year of Poggendorff's invaluable services was at the same time an ovation to a scientific veteran who has perhaps done more than any man living to encourage the highest forms of research, and a proof that in Northern Europe the physical sciences continue to be ably and actively cultivated. If in chemistry the case is somewhat weaker, the explanation, at least in this country, is chiefly to be found in the demand on the part of the public for professional aid from many of our ablest chemists.

But whatever view be taken of the actual condition of scientific research, there can be no doubt that it is both the duty and the interest of the country to encourage a pursuit so ennobling in itself and fraught with such important consequences to the well-being of the community. Nor is there any question in which this association, whose special aim is the advancement of science, can take a deeper interest. The public mind has also been awakened to its importance, and is prepared to aid in carrying out any proposal which offers a reasonable prospect of advantage.

[Several paragraphs follow on the introduction of scientific research among University studies.]

It may, perhaps, appear to many a paradoxical assertion to maintain that the industries of the country should look to the

calm and serene regions of Oxford and Cambridge for help in the troublous times of which we have now a sharp and severe note of warning. But I have not spoken on light grounds, nor without due consideration. If Great Britain is to retain the commanding position she has so long occupied in skilled manufacture, the easy ways which (owing partly to the high qualities of her people, partly to the advantages of her insular position and mineral wealth) have sufficed for the past, will not be found to suffice for the future. The highest training which can be brought to bear on practical science will be imperatively required; and it will be a fatal policy if that training is to be sought for in foreign lands, because it cannot be obtained at home. The country which depends unduly on the stranger for the education of its skilled men, or neglects in its highest places this primary duty, may expect to find the demand for such skill gradually to pass away, and along with it the industry for which it was wanted. I do not claim for scientific education more than it will accomplish, nor can it ever replace the after training of the workshop or factory. Rare and powerful minds have, it is true, often been independent of it; but high education always gives an enormous advantage to the country where it prevails. Let no one suppose I am now referring to elementary instruction, and much less to the active work which is going on everywhere around us, in preparing for examinations of all kinds. These things are all very useful in their way; but it is not by them alone that the practical arts are to be sustained in the country. It is by education in its highest sense, based on a broad scientific foundation, and leading to the application of science to practical purposes—in itself one of the noblest pursuits of the human mind—that this result is to be reached. That education of this kind can be most effectively given in a university, or in an institution like the Polytechnic School of Zurich, which differs from the scientific side of a university only in name, and to a large extent supplements the teaching of an actual university, I am firmly convinced; and for this reason, among others, I have always deemed the establishment in this country of examining boards, with the power of granting degrees, but with none of the higher and more important functions of a university, to have been a measure of questionable utility. It is to Oxford and Cambridge, widely extended as they can readily be, that the country should chiefly look for the development of practical science; they have abundant resources for the task; and if they wish to secure and strengthen their lofty position they can do it in no way so effectually as by showing that in a green old age they preserve the vigour and elasticity of youth.

If any are disposed to think that I have been carrying this meeting into dreamland, let them pause and listen to the result of similar efforts to those I have been advocating, undertaken by a neighbouring country when on the verge of ruin, and steadily pursued by the same country in the climax of its prosperity. "The University of Berlin," to use the words of Hofmann, "like her sister of Bonn, is a creation of our century. It was founded in the year 1810, at a period when the pressure of foreign domination weighed almost insupportably on Prussia; and it will ever remain significant of the direction of the German mind that the great men of that time should have hoped to develop, by high intellectual training, the forces necessary for the regeneration of their country." It is not for me, especially in this place, to dwell upon the great strides which Northern Germany has made of late years in some of the largest branches of industry, and particularly in those which give a free scope for the application of scientific skill. "Let us not suppose," says M. Wurtz, in his recent report on Artificial Dyes, "that the distance is so great between theory and its industrial applications. This report would have been written in vain, if it had not brought clearly into view the immense influence of pure science upon the progress of industry. If, unfortunately, the sacred flame of science should burn dimly or be extinguished, the practical arts would soon fall into rapid decay. The outlay which is incurred by any country for the promotion of science and high instruction will yield a certain return; and Germany has not had long to wait for the ingathering of the fruits of her far-sighted policy. Thirty or forty years ago industry could scarcely be said to exist there; it is now widely spread and successful." As an illustration of the truth of these remarks, I may refer to the newest of European industries, but one which in a short space of time has attained considerable magnitude. It appears (and I make the statement on the authority of M. Wurtz) that the artificial dyes produced last year in Germany exceeded in value those of all the rest of Europe, including England and France. Yet Germany has no special advantage for this manufacture, except the training of her practical chemists. We are not, it is true, to attach undue importance to a single case; but the rapid growth of other and larger industries points in the same direction, and will, I trust, secure some consideration for the suggestions I have ventured to make.

The intimate relations which exist between abstract science and its applications to the uses of life have always been kept steadily in view by this association, and the valuable reports, which are a monument to the industry and zeal of its members, embrace every part of the domain of science. It is with the greater confidence, therefore, that I have ventured to suggest from this chair that no partition wall should anywhere be raised up between pure and applied science. The same sentiment animates our vigorous ally, the French Association for the Advancement of Science, which, rivalling, as it already does, this association in the high scientific character of its proceedings, bids fair in a few years to call forth the same interest in science and its results throughout the great provincial towns of France, which the British Association may justly claim to have already effected in this country. No better proof can be given of the wide base upon which the French Association rests than the fact that it was presided over last year by an able representative of commerce and industry, and this year by one who has long held an exalted position in the world of science, and has now the rare distinction of representing in her historic academies the literature as well as the science of France.

Whatever be the result of our efforts to advance science and industry, it requires no gift of prophecy to declare that the boundless resources which the Supreme Author and Upholder of the Universe has provided for the use of man will, as time rolls on, be more and more fully applied to the improvement of the physical, and, through the improvement of the physical, to the elevation of the moral condition of the human family. Unless, however, the history of the future of our race be wholly at variance with the history of the past, the progress of mankind will be marked by alternate periods of activity and repose; nor will it be the work of any one nation or of any one race. To the erection of the edifice of civilized life, as it now exists, all the higher races of the world have contributed; and if the balance were accurately struck the claims of Asia for her portion of the work would be immense, and those of Northern Africa not insignificant. Steam power has of late years produced greater changes than probably ever occurred before in so short a time. But the resources of nature are not confined to steam, nor to the combustion of coal. The steady water-wheel and the rapid turbine are more perfect machines than the stationary steam-engine; and glacier-fed rivers with natural reservoirs, if fully turned to account, would supply an unlimited and nearly constant source of power depending solely for its continuance upon solar heat. But no immediate dislocation of industry is to be feared, although the turbine is already at work on the Rhine and the Rhone. In the struggle to maintain their high position in science and its applications, the countrymen of Newton and Watt will have no ground for alarm so long as they hold fast to their old traditions, and remember that the greatest nations have fallen when they relaxed in those habits of intelligent and steady industry upon which all permanent success depends.

A NEW COAL-CUTTING MACHINE.

A COAL-CUTTING machine recently put to work in a mine at New Straitsville, Ohio, is described as follows in our contemporary the "Coal Trade Journal," of New York:—

The machine proper consists of a bar of iron or steel, 2½ ft. long by 2 in. square, in which is placed twenty-five picks or cutters. These cutters, and the bars in which they are securely fastened, are driven by two small engines using compressed air as the motor. The engines, being so very small (4 × 5 in.) are enabled to go fully five hundred revolutions per minute in perfect safety, thereby imparting a rotary motion to the head, where the cutters are placed, of one hundred revolutions per minute, every revolution driving the head in one-third of an inch, by means of screw rod and nut similar to Frim's miner's coal drill, now so extensively used in the Shenango Valley. By reversing the motion the same screw which drives the head in draws it out for a new cut into the coal. The machine is 2 ft. 9 in. high, and at present 6 ft. long, and is calculated to make a "bearing in" 5½ ft. deep and but *four inches high*. The power (compressed air) is obtained by two coupled air-pumps placed at the air-shaft, and carried to the cutter through a rubber pipe 1¼ in. in diameter. The total cost of all will not exceed $3,000. It is claimed that with this machine three men can "bear in" and drill the holes for a blast in one hour which would require four men a whole day; or three men and the machine can do as much as thirty miners can in a given

time. It is also said that the wastage is less than that made by hand diggings. Mr. Litchner, of Tuscarawas county, Ohio, is the inventor and patentee. It is stated that he has spent fifteen years in devising and perfecting a method of cutting coal by machinery, and the present machine is the result. The machine being so low (only 2 ft. 9 in. high) can be operated in almost any mine, and if it can accomplish anything near what is claimed it is a most valuable invention, the adoption of which would cheapen the cost of coal and relieve the operator from the periodical strikes that now so seriously interfere with his business. A good mechanical coal digger is emphatically a much needed aid in the production of coal.

Practical Literature.

INTRODUCTION TO THE STUDY OF CHEMICAL PHILOSOPHY.[1]

THE rapid advances which have been, and are still being made, in the domain of chemistry, together with the impetus which science, as a branch of education, has of late received, have called forth from the press a perfect flood of cheap manuals upon this the "Queen of the Sciences." Unfortunately, but a small proportion of these can be deemed of any great value as educational works, while many are worse than useless.

The work before us is a very welcome addition to what may be correctly termed "cheap," as well as "low-priced," scientific literature, and is the more welcome because it is an endeavour to supply a gap in that literature, and to direct the attention of teachers and students to the spirit in which this, and indeed, all other branches of science, should be studied. As the author very justly complains, it has become too much the fashion to teach chemistry strictly with a view to its practical application and results, rather than as a study whereby the higher faculties of the intellect may be cultivated.

In this age of mammon-worship, the fashion of guaging the value of a study by its mere commercial equivalent has become very prevalent, and has conduced largely to that most objectionable method of acquiring, or rather, of attempting to acquire, knowledge, to which the perhaps coarse but expressive term "cramming" has been applied. We therefore hail with pleasure this attempt to set before the student the true aim and object of his studies, and to impress upon him the necessity of viewing the facts and phenomena of chemistry as the outcome of inexorable laws, to the discovery and study of which they are but stepping-stones.

This *Introduction to the Study of Chemical Philosophy* is intended as a supplement to the ordinary elementary manuals of chemistry, such, for instance, as the admirable one by the late Professor Miller, in the same series. In these manuals the attention of the student is necessarily directed mainly to the elementary facts and phenomena of the science, while but a small portion of the work is devoted to the exposition of the theories by which those facts and phenomena are sought to be explained, and to the laws of nature which they exemplify. To the student who has fairly mastered such a manual, the present work, intelligently used, will prove a material assistance in the acquisition of a thorough grasp of the theoretical portion of his subject, and of its connection with the other branches of physical science.

The first section of the book is devoted to a lucid and comprehensive review of the connection of chemistry with the kindred science of physics. The constitution and various conditions of matter, and the molecular theory are carefully treated, and under the head of "solution," a brief but clear description of Professor Guthrie's recently discovered "cryohydrates" is given, affording an instance of the manner in which the work has been brought down to the present date. The subject of Spectrum Analysis, as far as it relates to chemical science, is also clearly expounded. The remaining sections of the work treat of matter in what may be termed its strictly chemical relations. The atomic theory of Dalton, and its subsequent modifications receive due attention. The chapter upon nomenclature is well worthy attentive perusal, as in it will be found a very clear explanation of the principles upon which the modern names of elementary and compound bodies are based. It is greatly to be regretted that, owing to the, so to speak, disconnected manner in which the elementary bodies have been discovered, no regular system of naming them, or their compounds, was introduced until long after many of them had acquired names, given to them hap-hazard by their discoverers, by which they have become so well known, that it is hopeless to attempt to re-christen them. The consequence is, that the student is met on the threshold of his studies by a difficulty which it is often a work of considerable time and labour to overcome, and the difficulty is heightened by the fact that in very few text books is the modern system of nomenclature carried out in its integrity. A clear description of the principles upon which this modern system is based, and of the exceptions to it, which long usage in some instances renders necessary, is therefore valuable to the student, and will greatly assist in a clear comprehension of this part of his subject. An innovation which the author recommends in the name of the element selenium is, though a small matter, perhaps worthy of attention. This element when first discovered was thought to be a metal, and its name in accordance with the system was therefore made to terminate in "ium." It was soon, however, found to be a non-metallic element, but was allowed to retain its original name. In the present work this is converted into "Seleion," which destroys the anomaly, a precedent for the alteration being found in the conversion under similar circumstances of *silicium* into *silicon*.

The subjects of Quantivalence, and Graphic and Constitutional Formulæ are very fully and lucidly explained, and with careful perusal will be readily understood by the general reader, as well as by the professional student. An exhaustive classification and description of the general properties of the elements is given, and the work concludes with a consideration of the properties of the principal compound bodies, including the numerous and important carbon compounds.

The style of the work throughout is lucid and interesting, and while technicalities are not discarded, they are used with discretion, and clearly explained.

We can, therefore, heartily recommend Mr. Tilden's book as a very valuable addition to the standard works upon educational science, and one which will well repay perusal by all interested in the subject.

[1] *Introduction to the Study of Chemical Philosophy.* By William A. Tilden, D. Sc. F.C.S. London: Longmans, Green and Co. 1876.

SANITARY WORKS ABROAD.[1]

THIS pamphlet is another indication of the increasing interest at present existing in all matters pertaining to the improvement of our sanitary arrangements. In our last issue we had occasion to notice two works bearing on the question of sanitary arrangements in our smaller towns and villages,[2] and we have now this pamphlet dealing with the same subject in connection with the two largest cities of the Continent. It consists of a translation extracted from the "Annales des Ponts et Chaussées" of the Report of the Commission appointed to propose measures for remedying the pollution of the Seine in the vicinity of Paris, and a description of the works in course of execution for the sewerage of Berlin, and the application of the sewage to irrigation at Marienfelder and Falkenberg. It is instructive to note that in Berlin the proper drainage, water supply, and ventilation of private houses are made compulsory, and neglect on the part of the owners is punished by fine or imprisonment. A careful study of this pamphlet will show, what it indeed would seem unnecessary to insist upon, that the three requisites to domestic salubrity are water, drainage, and ventilation, of which the *point d'appui*, as M. Nulle truly says, is the water-closet. Badly constructed, badly trapped, unventilated, it becomes a domestic Upas. Upon this point we would refer our readers to the two works reviewed in our last number, and especially to Mr. W. Paton Buchan's excellent little book on plumbing. Such, however, is the cupidity or the ignorance, or both, of owners in this country that we feel no doubt until such compulsory regulations as are found necessary in other large cities are put into force, London will not be rid of the evils which the absence of a proper attention to this important subject creates.

[1] *Sanitary Works Abroad:* I. *Assainissement de la Seine;* II. *Assainissement de Berlin.* By Robert Manning, M. Inst. C.E., Chief Engineer to Her Majesty's Board of Public Works in Ireland. London and New York: E. and F. N. Spon. 1876.

[2] See PRACTICAL MAGAZINE for August, No. 20, New Series, p. 256.

A PRACTICAL TREATISE ON ROADS, STREETS, AND PAVEMENTS.[1]

IN a country like America, where such operations as the opening up of new roads are of comparatively frequent occurrence, a work like the one before us, which apparently was written primarily with a view to transatlantic requirements, will possess a special interest and value. That part of the work which refers to the locating of country roads and the methods of constructing them is of far more use in a new country like America than in England, where modern civilization has found so many of its roads made for it under a régime almost as civilized as the present, but which has long since passed away. These remarks, however, be it understood, are made in no deprecatory sense, but rather as indicating the special features which make the book useful for colonists and settlers in countries to which the march of civilization has not as yet thoroughly penetrated. For these the book possesses a unique value; it is small in size, and yet treats comprehensively on all such points as the methods of constructing road coverings, with their essential details, making also numerous practical suggestions with respect to the selection and application of materials, more especially those with the properties and uses of which builders are presumed to be the least acquainted. But to us dwellers in cities, for whom road-making in the wilds of Australia or the far West can have comparatively little interest, except so far as it illustrates certain fundamental principles of which it is important not to lose sight, the most attractive portions of this work are those which treat of the respective merits of the several street pavements now competing for popular recognition and power, and which institute comparisons of their respective merits, under the varying conditions of traffic, climate, and locality to which they are commonly subjected.

For the majority—since we none of us can dispense with walking or riding in the streets of our great cities—the question of street pavements will, as we have said, possess the greatest interest; and our author lays down clearly what the essential requisites of a good street pavement are, viz.: "that it shall be smooth and hard, in order to promote an easy draught; that it shall give a firm and secure foothold for animals, and not become slippery by use; that it shall be as noiseless and as free from mud and dust as possible; and that it shall be easily cleansed, and shall not absorb and retain the surface liquids, but facilitate their prompt discharge into the side gutter catch basins. It should also be of such material and construction that it can readily be taken up in places and quickly and firmly relaid, so as to give easy access to water and gas pipes; facility of repair at all seasons of the year is another important requisite. Economy of maintenance and repair require that the material of the surface shall be durable." He then proceeds to describe the various methods which have been employed, and which are still in use, such as cobble-stone, rubble-stone, stone blocks, wood, asphalte, &c. &c. This is done in detail, and different kinds of foundations are discussed with the same completeness that characterizes the treatment of all the other sections of his book. After a careful survey of the various methods in use our author sums up as follows:—

"Upon hygienic grounds, therefore, asphalte conspicuously stands first, stone second, and wood third, in order of merit. The correct inference from the foregoing discussion is, that no one pavement combines all the qualities most desirable in a street surface. It cannot be sufficiently rough, or sufficiently soft, to give the animals a secure foothold, and at the same time possess that smoothness and hardness which is so essential to easy draught. The advantages of open joints and entire freedom from street filth cannot exist together under any reasonably cheap method of cleansing the surface. A pavement of impermeable blocks, if laid upon a solid foundation, may be constructed and maintained in a water-tight condition by thoroughly caulking the joints with suitable material, leaving the surface sufficiently rough and open to obviate the objection to a continuous monolithic covering; but roughness, combined with the requisite hardness, is incompatible with the freedom from noise attainable with some kinds of acceptable street surface. In order, therefore, to obtain the best pavement for any given locality, a judicious balancing of characteristic merits is generally necessary. The best pavement, so far as we now know, for all the busiest streets of a populous city, where the traffic is dense, heavy, and crowded, is one of rectangular stone blocks set on a foundation as good as concrete, or as rubble-stone filled in with concrete; and the next best is one of Belgian blocks, set in the same manner. The best pavement for streets of ample width, upon which the daily traffic is not crowded, or for streets largely devoted to light traffic or pleasure-driving, or lined on either side with residences, is continuous asphalte for all grades not steeper than 1 in 48 or 50."

We have left ourselves no space to speak of the many other interesting subjects dealt with in the book—such as the various kinds of side-walks, footpaths, tramways, and street railways; and our notice of the work would be incomplete if we did not refer to its great practical value in describing, not only the materials to be used for every kind of road making, but the best mode of manufacturing them, the careful comparison of cost of different materials and the labour connected therewith, and the many excellent suggestions of improvements with which it abounds.

[1] *A Practical Treatise on Roads, Streets, and Pavements.* By Q. A. Gilmore, A.M., Lieut.-Col. U.S. Corps of Engineers, &c. New York and London: E. and F. N. Spon. 1876.

PRINCIPLES OF CONSTRUCTION AND EFFICIENCY OF WATER WHEELS.[1]

THIS is a work of extreme usefulness, although to but a very limited public. All those, however, who are practically concerned in the utilization of water as a motive power, will be thankful to the author for the care which he has bestowed upon the compilation of his work, which is, within the points which he has proposed to himself, exhaustive without prolixity, and thoroughly practical in every sense of the word.

It is devoted, first, to the investigation of the effect of the impulse of water against vanes, the general principles of construction, and the efficiency of the different classes of vertical wheels; and secondly, it treats of the efficiency, principles, and details of construction of the working parts of the three classes of turbines—outward, inward, and parallel flow.

There is, as is well known, very considerable divergence of opinion upon many points connected with this difficult and intricate subject; numerous kinds of turbines have been invented, and each inventor claims for himself a superiority over all others. Our author does not discuss these different inventions, except in one or two cases; but we think it would have added to the interest of the work if he had given us some account of the more important of them. His book, however, as a whole, by laying down the principles by which the efficiency of water wheels can be tested, will suffice, as a guide, for the selection of those which possess the greater power.

BUILDING CONSTRUCTION.[2]

THE advantage of compilation consists in the gathering together of materials that are common to the world, and classifying them. Science and Art are greatly aided by the labour of the compiler, because the young student is able to see with small labour the whole history and facts of a hundred years in relation to the particular object to which he is devoted. And in education it is found absolutely necessary to use text-books which are merely compilations; "precedent on precedent" is really a necessary condition even of so volatile and changing a theme as the facts of science or art. The Committee of Council on Education have laid down certain rules on this subject which they term a Syllabus, and students have to shape their acquirements to satisfy the conditions, if they desire the certificate of that body. It is, therefore, manifestly necessary that the candidate accept the discipline. The work before us is designed to compass that object, and is a most minute description of every stage in the construction of buildings; of every material that is employed; of every thickness, weight, use, and danger that appertain to building; and the mechanical laws that claim obedience, whether it be in using less or more of material, less or more of angle, less or more of strain. As every part is fairly sketched, he must be a very dull scholar who cannot learn. These sketches number more than 300. A full index is appended. The ordinary builder will find it a most useful book, especially as to the exact terms of parts, and the laws which govern the combination of materials.

[1] *Principles of Construction and Efficiency of Water Wheels.* By William Donaldson, Assoc. Inst. C.E. London and New York: E. and F. N. Spon. 1876.

[2] *Notes on Building Construction, arranged to meet the Requirements of the Syllabus of the Science and Art Department of the Committee of Council on Education, South Kensington.* Part I. First Stage or Elementary Course. Rivingtons: London, Oxford and Cambridge. 1875.